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THE MISSILE/SPACE WEEKLY

MAY 1961
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Will U.S. Compete With Russia In Race For Moon?

- **No Easy Cure For Booster Gap**
- **AF to Orbit Apes for Weeks**
- **'Space Drive' System Debated**

Sperry's Tube Test Plant

AN AMERICAN AVIATION PUBLICATION

Monsanto

Space-Age Project "SUPER THRUST"

A CHEMICAL EXPEDITION



..exploring hydrocarbons for High-Mach fuels... seeking new paths to heat stability

santo research is making significant strides forward ie search for heat-stable hydrocarbon fuels for the generation of jet engines. Working under contract with ropulsion laboratory, Wright Air Development Divi-. Monsanto chemists are blocking out a variety of ocarbon compounds for fuels "task-tailored" to en- design requirements. These fuels promise to meet hree most pressing fuel requirements:

High thermal stability
High energy per unit of weight and volume
Optimum heat-transfer capability

To meet stringent fuel requirements as they become more closely defined for advanced jet engines, Monsanto has screened some 6,000 chemical compounds. More than fifty hydrocarbons have been selected for intensive evaluation based on their promising physical properties.

From the exhaustive search and confirming experimentation, Monsanto research has determined that a hydrocarbon fuel is within reasonable reach that will not decompose or "gum" in the 600°-800° F. range. Its high heat stability will enable it to serve as the heat sink . . . essential in advanced-design jets to relieve the lubricant, engine components, thrust chamber and "skin" from heat stresses.

IMPROVED DUAL-PURPOSE FUEL: ENERGY AND HEAT SINK, HEAT STABLE, SUPER THRUST

From current study, it appears that the compound with optimum jet fuel properties may turn out to be either a relatively simple mixture of highly "pure" cyclic, saturated chemicals or narrowly selected fractions of refinery streams, hydrogenated to saturation and carefully separated. This necessarily would be a chemically made fuel, not a run-of-refinery mixture. As such, it would provide more closely defined physical and chemical properties for predictably uniform performance.

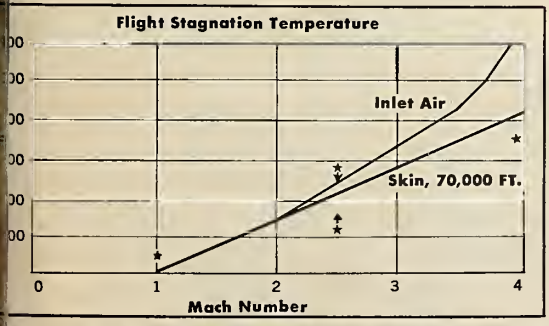
Its requirement parameters are becoming fairly clear: BTU's per pound—18,500 to 19,000 minimum; specific gravity—0.85 to 0.95 (or heavier); no coking or "gumming" to 800° F. In addition to heat stability, next-generation jet fuels must have maximum heat of combustion (on a weight-and-volume basis) to increase the jet craft range.

Monsanto is in an unusually sound position to help engine makers and the military in solving the fuel problem. Its Special Projects Laboratories are staffed and oriented for precisely this type of research. In addition, Monsanto's Organic Chemicals Division has a basic position in aromatic compounds. Through its Lion Oil Division, Monsanto has a basic supplier position in refinery products (and the research facilities) to study the possibilities in paraffins, naphthenes and close cuts of refinery streams.

Several candidate fuels have already been prepared and manufactured in evaluation quantities; for example, isopropylbicyclohexyl. Study is continuing in many other areas, including both naphthenes and paraffins. Most important, with a variety of "candidates" Monsanto next needs to know specifications based on design: the density limits, exact heat stresses, minimum thrust limit. With these parameters "jelled," Monsanto can guide the engine maker to a variety of candidate cyclic or paraffinic hydrocarbons for evaluation.

ENDOTHERMIC-REACTION FUELS— ANOTHER AVENUE TO "SUPER THRUST"

Chemically, there is little chance that a saturated hydrocarbon fuel stable above 900° F. will be found.



At subsonic speeds, engine heat can be dissipated by convection to the air. At speeds higher than Mach 1.4, the rate of air cooling reaches borderline; at High-Mach speeds, air cooling is inadequate. The frictional heat of aerodynamic drag and the reject heat of engine combustion must be dissipated to some part of the vehicle or its load. Conventional liquid JP-4 fuel, a refinery stream hydrocarbon cut, reaches its borderline limits of heat stability near speeds of Mach 2.5. Fuels having higher limits of heat stability are required.

Approximate cooling requirements:

Mach Number	HEAT SINK, BTU/lb. of Fuel Required	Available JP-4 †
1.0	★ 130	170
2.5	★ 220-550	170
4.0	★ 725	170

† Conventional liquid jet fuel heated from 100-400° F

(*Please turn page*)

However, a fuel system may be developed—with compounds capable of undergoing endothermic reactions—that will operate in environments in the 1200-1900° F. temperature range. Basically, this requires the development of a compound to be converted *in flight* to the actual fuel, in a "package" chemical converter that would utilize part of both the reject heat of fuel burning and the friction heat of aerodynamic drag. Endothermic fuels show promise of increasing vehicle range through greater fuel efficiency, since heat energy normally lost is absorbed during the endothermic conversion and released during combustion. A few of the promising possibilities programmed for experimentation:

THERMAL CRACKING OF HYDROCARBONS:

Cracking:

$$C_8H_{18} \longrightarrow C_4H_8 + C_4H_{10}$$

Heat Absorbed: 370 BTU/lb.

DEPOLYMERIZATION TO OLEFINS:

Diisobutylene

$$CH_2{=}C(CH_3)CH_2\,C(CH_3)_3 \longrightarrow 2\,(CH_3)_2C{=}CH_2$$

Heat Absorbed: 390 BTU/lb.

RETRODIENE SCISSION:

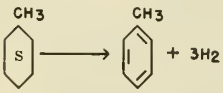
Monomerization of dicyclopentadiene



Heat Absorbed: 310 BTU/lb.

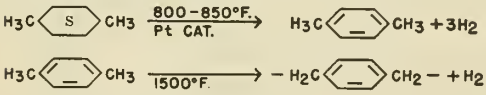
DEHYDROGENATION AND AROMATIZATION:

Dehydrogenation of 6-membered naphthene to an aromatic



Heat Absorbed: 900 BTU/lb.

STABILIZED HIGH-TEMPERATURE FREE RADICALS (Series Reaction):



Total Heat Absorption (sensible heat plus heat of reaction): 3080 BTU/lb.

Monsanto research has blocked out several more "types" of endothermic reaction, each with dozens of specific compositions, as promising starting points for heat-sink fuels to power supersonic craft.

CHEMICAL FUELS — ANOTHER CHEMICAL CAPABILITY OF MONSANTO

Where design and fuel performance are interdependent, you are invited to enlist Monsanto's capability on the chemistry of the fuel. Write or call: MONSANTO CHEMICAL COMPANY, Department MR-4, C Building, St. Louis 66, Missouri.

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THE MISSILE / SPACE WEEKLY

missiles and rockets

Volume 8, Number 18 May 1, 1961

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THE COVER

Technician adjusts spark gap which helps to protect against overload of multimegawatt power supply at Sperry Gyroscope's million-dollar tube test plant. See p. 41.

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attack

Today's pilots traveling at supersonic speeds must seek out targets they cannot see. To make low-level attacks in any weather, day or night, requires highly sophisticated electronic aids. Autonetics meets this need with advanced radars using terrain avoidance equipment, bombing-navigation systems and projected displays. Such are: NASARR, a compact, lightweight, monopulse radar system in F-105's of the USAF, the F-104's of Canada, West Germany, Belgium, Netherlands and Japan; and the AN/ASB-12 radar-equipped, inertial bomb-nav system in the Navy's Mach 2 A3J.

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Wire and Cable Report

To the Editor:

Your special report on "Snarls in Missile Wire and Cable Industry" (M/R March 27) is of extreme value to engineering types such as we have in Launch Control Systems.

Ours is a group of 100-150 design engineers concerned with the many technical specifics of cable interfacing between pieces of console equipment, blockhouse-to-launch pad transmission lines, and vehicle umbilical tie-ins.

More such splendid articles in the actual area of applied hardware would be a feather in M/R's cap and a real common denominator for all firms similarly engaged in the missile launch business.

Gene H. White
Staff Engineer,
Launch Control Systems
Missile Systems Div.
Lockheed Aircraft Corp.
Van Nuys, Calif.

To the Editor:

On page 24 of your special report is a chart comparing the various materials used for insulation. Under TFE-Teflon, you comment that this material is available only in short lengths.

With the constant effort being applied by the processors of TFE to meet all the various design requirements, we can now supply this material in continuous lengths for all sizes that may be required. The design engineers should be aware of the progress that has been made in eliminating the many past problems in processing TFE.

H. Jack Kipnes
Tri-Point Industries, Inc.
Albertson, N. Y.

To the Editor:

Your report was read with interest and you are to be complimented on your efforts to improve matters in this area; however, it is felt that some of your remarks require clarification.

The subtitle would indicate that all of the problems were with the wire or cable, whereas most of the problems brought out in detail are primarily connector and termination difficulties. High quality and very reliable bulk cable with even the most complex components is available from several qualified suppliers with reasonable lead time and competitive prices, but the connector situation in most cases is a sole-source proposition—with long backlogs, particularly on non-standard connector types.

There has been an extremely small amount of difficulty with properly manufactured wire and cable in the field. Many of the problems mentioned in your article were caused by using "jacketed harnesses" as a substitute for cable. I am not aware of any *cable manufacturer* who has failed and closed his doors. The companies I believe your article referred to were harness manufacturers who bundled up wires, in many cases surplus or other inferior quality, and pulled a garden hose-type of jacket over these crudely assembled conductors and sold these jacketed harnesses as cable. It has been these inferior constructions which have been at fault in almost every instance of cable failure.

The general adoption of MIL-C-13777 as a control by the missile contractors has cured most of the wire and cable ills, and this specification certainly allows adequate leeway in manufacturing techniques. If any process limitation in the specification were relaxed, the door would be opened to some of the techniques which permit the shoddy cable mentioned in your article.

You also neglected to mention MIL-C-27072 for non-portable instrument and control cable as an adjunct to MIL-C-13777, which covers portable data and power cable. MIL-C-27072 allows wide choice of materials for applications where the cable is installed in protected areas, but it is extremely important in the use of this specification that all quality control measures be carried out exactly as specified throughout the manufacturing of the cable to avoid an unreliable finished product.

We believe that the top item on the list of what needs to be done is to break the connector bottleneck—standardize the connection device and make it reliable and capable of taking the same kind of abuse as does the cable itself. It seems very unreasonable to build the cable to take severe mechanical abuse while the aluminum connector attached to the end of the connector can, if dropped, be damaged to the point where it is useless.

We would also like to amplify your point that MIL-C-13777 cannot be effective unless the military enforces it as a minimum requirement. In many instances missile primes deviate from the specification by setting out further requirements for their particular application. This freedom must be allowable.

D. C. Alexander
Chief Engineer
Surprenant Mfg. Co.
Clinton, Mass.

To the Editor:

Your article, "Study in Near Chaos," was very interesting to us at Scintilla.

We have been in the harness business for 30 years, and during this time have designed and built harnesses for many critical uses—aircraft, missiles, nose cones, etc.

While we have had our troubles from time to time, I can't recall any chaotic conditions.

Your article concerns itself primarily with GSE cables and we, for the past 4 or 6 years, have been concerned with this type of cable. As you say, procurement of special cables having a veritable "smorgasbord" of wires was and is a serious problem. We do not share your enthusiasm for the Triple 7 cable, although in some installations its use is indicated and, if so, we do use it. For the most part we find:

1. The delivery poor,
2. Vendors not interested in short-length requirements,
3. Requirements cannot be met for the special patterns needed,
4. Special patterns would need lengthy approval tests,
5. Design people specify it promiscuously for branched harness assembly, where it just isn't applicable,
6. Not economical unless you purchase mile lengths.

Because most of our cable business is branched assemblies requiring comparatively short lengths, usually of special cable, we have built a new facility at Santa Ana, Calif., to provide reliable cable for these needs.

Bendix is not a "Johnny come lately" in this business and we are making and intend to continue to make quality cable assemblies. . . .

J. C. Cole
Chief Engineer
Scintilla Division
The Bendix Corp.
Sidney, N. Y.

NASA, Si, Cuba, Non

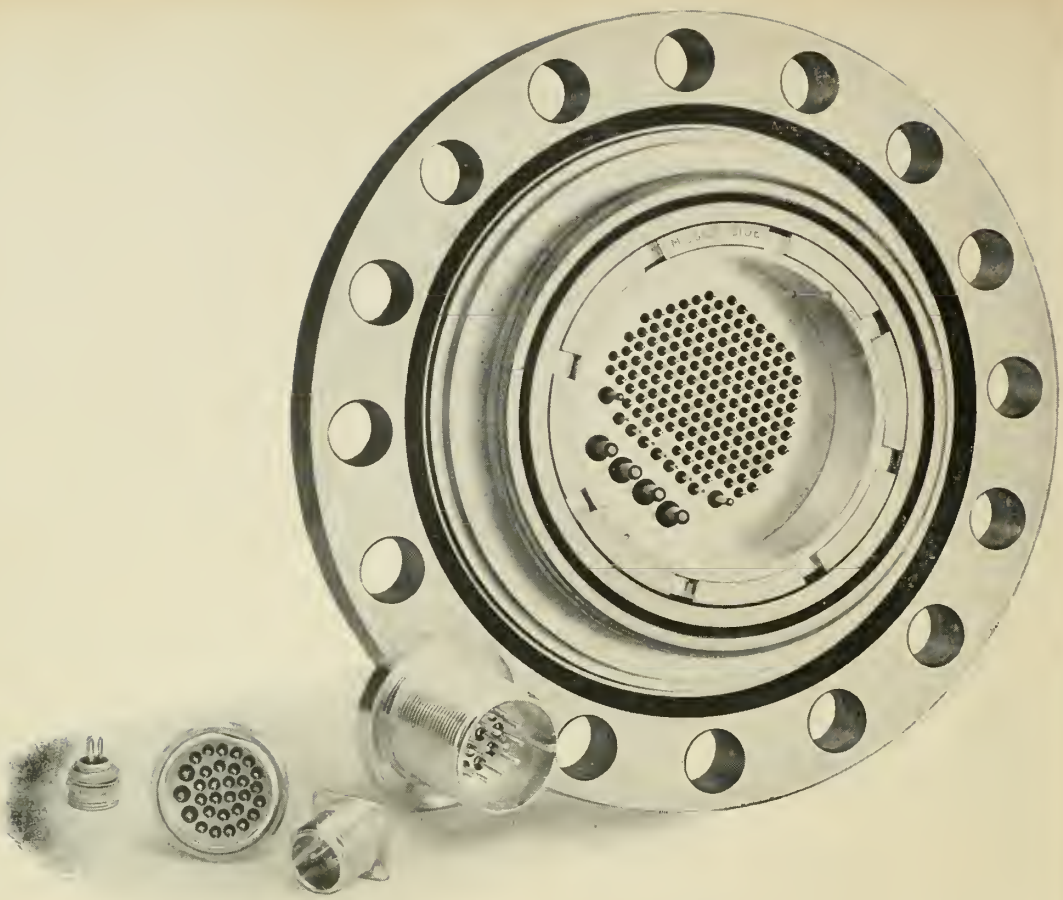
To the Editor:

I find much merit in a publication that editorializes objectively—the species is dwindling rapidly. M/R's previous editorials seemed to epitomize detached appraisal—straight reporting, if you will. I am cognizant that it is almost protocol in the realm of the fourth estate to editorialize as per the publisher's or editor's personal view; and I certainly don't deny the validity of that privilege. However, I am rather tired of the almost universal dedication of editors' pages to the gods of expediency. Your whitewashing job of the 6th inst. in re James E. Webb ("Let's Not Hang an Untried Man") augurs of things to come, and I'm disappointed. In your opening paragraph you stress the magnitude of the task that lies ahead, you follow with the assertion that the success or failure of NASA can imply global repercussions, but you rather leave me in the dark as to the specifics from "some scientific quarters" and the "weekly aviation publication" as to Mr. Webb's alleged inadequacy. In effect, then, you take the position that since the President appointed him, he should be given a chance, and until he errs, opposition is unfair. Now, I could be wrong on this—and I sincerely hope I am—but is this the same Webb whom the dim, dark memory circuits of my little brain connect with the State Dept.'s monumental blunder in the Cuba debacle? Even if he's not the same person, I deplore M/R's sanction of Presidential appointments just because. The N. Y. Times did the same with Mr. Eisenhower for years, and he pulled *some* rocks.

Thanks for listening—and I still think the rest of the magazine is real fine.

Herbert R. Brown
College Point, N. Y.

NASA's Webb was not the gentleman involved in the Cuban events.—Ed.



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The Countdown

WASHINGTON

Congress Waits for JFK on Space

Congress is continuing to mark time while the Administration decides what to do about Russian gains in space. But individual congressmen are growing increasingly uneasy. Basically their plea to the White House is: Do Something. The outlook: Possibly a message to Congress by the end of May.

Minuteman Snagged?

Second flight test of the *Minuteman* ICBM is still six weeks to two months away, which will put it at least four months from the first shot on Feb. 1. There have been repeated rumors of guidance problems with the bird, but no confirmation that this may be the source of the long delay between flight tests.

The High Cost of Capsule Catching

One of the most hidden figures in the U. S. space program is the cost of the Navy-supplied *Mercury* capsule recovery team. The O&M figure is conservatively estimated in the millions. For the *Mercury-Atlas* launching April 25 the Navy had at sea in the Atlantic between Cape Canaveral and the Canary Islands; 10 destroyers, an air salvage vessel, a landing-ship dock and an oiler. The Navy also provided 21 aircraft.

Polaris I, Polaris II Score

The Navy now has launched 20 operational *Polaris I's* from submerged subs for a score of 12 successes and 8 failures, and it claims previous difficulties have been eliminated. Meantime, the *Polaris II*—the *A2X*—has been successfully launched twice from the Observation Island Test Ship, a major step in the R&D test program. Added note: The nuclear-powered submarine Robert E. Lee—third of the *Polaris* fleet—is expected to deploy in a matter of weeks at most.

Saturn: Is It Too Late?

Several officials close to the *Saturn* program insist there is little chance of speeding up the *Saturn C-1* flight schedule through Shot No. 10 by pumping more money into the program. However, the same officials say at least several months might be saved by cutting red tape between Washington and Huntsville.

INDUSTRY

NAA Atomic Division Grows

Six new functional divisions are being formed in North American Aviation's Atomics International to carry out "expanding programs in the nuclear power and space fields." The new division chiefs: Dr. A. B. Martin, compact systems; Dr. Signey Siegel, power systems; Dr. H. P. Reiss, research; Dr. Harry Pearlmen, general development; W. L. Sequeira, acting manager, administration; and R. K. Holbrook, general services.

Missile Dollars: From Peter to Paul

The Navy expects to save $57 million by cancelling all work on the Bendix air-to-air *Eagle*—$10 million in FY '61 and $47 million in FY '62. All of it will be used in FY '62 for augmenting "Navy limited war capability requirements" and accelerating R&D work on the *Super Polaris*—the *A3*.

Burial for Corvus

Temco is closing down its Point Mugu, Calif., office after firing the last missile of the defunct *Corvus* program on April 14. The air-to-surface bird was killed last July by the Eisenhower Administration.

R&D Intelligence

The Navy is now ready for a full-scale launch test in Project *Hydra*. A ten-ton boilerplate mockup recently fired from Point Mugu, Navy says, "proved" feasibility of launching boosters of almost any weight directly from the sea. . . . For Boeing in the *Dyna-Soar* program Vacudyne Corp. of Chicago is building a $110,000 high-altitude chamber with an explosive decompression feature to simulate meteorite punctures. . . . Static testing of *Saturn SA-1*, the first flight-test vehicle, will begin at Huntsville shortly. The booster will be shipped to Cape Canaveral late in the summer, if it meets quality acceptance.

Launcher Change for Saturn

NASA is eliminating water cooling for the *Saturn* launch pad at the Cape—at an estimated saving of $3-$4 million. Instead it will use an inverted V-shaped flame deflector.

INTERNATIONAL

U.S. Firing Missiles in Hebrides

American troops will use a British range in the Hebrides to practice-fire 75-mile-range *Sergeant* surface-to-surface missiles next month. The exercise will last about two weeks.

Monkeys in Nipponese Space Tests

Japan is planning to launch several female monkeys on one-way trips into space this fall with three-stage *Lambda* rockets, which weigh one ton and measure about 30 ft. No recovery attempts will be made in the shots expected to reach 650 miles. In its first static test April 24, a *Lambda* exploded after 10 secs.

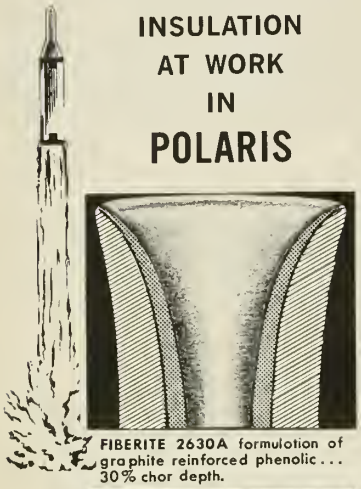
Overseas Pipeline

Ferranti Electronics of Britain is getting ready to market epitaxial transistors later this year. . . . Nord Aviation may make a licensing deal with Mitsui & Co. of Japan to manufacture antitank missiles for sale in Japan and Southeast Asia. . . . Yuri Gagarin is expected to visit Britain in July—first stop in a glad-handing goodwill tour for Russia.

example...

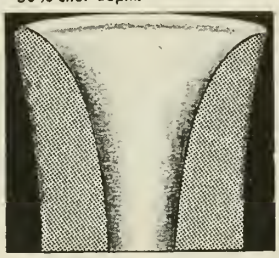
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MOLDING COMPOUNDS

The Missile/Space Week

Base Mess Stirs Congress

Congress may step into the missile base construction mess to halt further slippage.

Senate Investigations Subcommittee head John L. McClellan cited Air Force testimony that "something more than we have" is needed to prevent further work stoppages.

A total of 50,550 man-days have been lost at ICBM sites since construction began through March 31, 1961. Combined with days lost because of strikes at Air Force missile test sites—Edwards AFB, Vandenberg and Patrick—the total comes to 162,872.

Some of the harder hit bases are: Warren AFB, Cheyenne, 23,664 man-days lost; Forbes AFB, Topeka, 6,935; Offutt AFB, Omaha, 6,642; Lowry AFB, Denver, 3,204; Walker AFB, Roswell, N.M., 2,297; Larson AFB, Moses Lake, Wash., 2,633; Lincoln AFB, Neb., 1,743; Fairchild AFB, Spokane, 1,241.

A total of 19 operational sites were included in the Air Force survey.

Further DOD Blackout?

Tighter censorship control over defense information is being proposed for the Assistant Secretary of Defense for Public Affairs.

The draft directive would give Assistant Secretary Arthur Sylvester clearance over all DOD actions which have "public affairs implications of national or international significance."

Sylvester recently put a blackout on release of results of missile launchings unless they are clearly within sight of the public.

NASA Called Bad Example

NASA's man-in-space program has been labeled a "crucial illustration" of the serious lack of information coordination in government-financed science and research programs.

A Senate report attacked NASA for not having a central index for all its "in-house" and outside R&D projects. "The program's entire pace and success depend upon mastery of up-to-the-minute classified and non-classified information on current development projects," said subcommittee head Sen. Hubert Humphrey.

The report also cited the total lack of an indexed interagency inventory of the 160,000 government projects involving $8 billion in Federal funds.

Propulsion Lead Claimed

The revolutionary high-energy propulsion technology under development for *Centaur and Saturn* will give the U.S. "true firsts," the NASA propulsion chief declares.

Elliot Mitchell, assistant director for propulsion, also told an American Rocket Society meeting at Palm Beach, Fla., that America starts the race with Russia to develop nuclear and electric propulsion with a decided advantage.

"This is no basis for complacency," Mitchell asserted. "Far from it. We intend, however, to maintain and increase this margin of lead to the best of our ability. We are fully aware that, historically, progress in aviation



Shot of the Week

SLICKED-UP Pershing missile with new, more sharply tapered nose cone and more powerful motors lifts off transporter-erector-launcher to fly an extended distance for the first time.

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has been paced over the last 60 years by the availability of advanced propulsion techniques."

He said America's future propulsion plans all are built around the use of liquid hydrogen.

First Lunar Re-entry Test

A seven-stage rocket last week propelled an artificial meteor back into the atmosphere in America's first experiment at simulating lunar re-entry.

A tiny seventh stage on a *Trailblazer I* solid rocket propelled a small steel pellet to re-entry speed of about 25,000 mph—the velocity an object would enter on falling back to earth from a lunar mission.

The first three stages carried the assembly to an altitude of 175 mi. Final four stages propelled downward. A 5-in. spherical rocket was the seventh stage.

NASA's Langley Research Center, MIT Lincoln Laboratory, Air Force-Cambridge Research Laboratory and Harvard College Observatory jointly sponsored the experiment April 21 as part of a series on re-entry launched from Wallops Island, Va. Research data was obtained by optical and radar tracking. There was no telemetry gear.

Martin Sells GPE Stock

The Martin Co. is relinquishing its 15% holding in General Precision Equipment Corp.

The action apparently was brought about because of an antitrust suit filed by GPE in February charging Martin with an attempt to take control of the company. The Martin Co. denied the charge but said it would sell its stock to avoid legal entanglements

X-15 Sets New World Mark

The first full-power test of the *X-15* rocket plane with the Reaction Motors XLR-99 engine pushed the craft to a world's speed mark of 3074 mph on April 21. Maximum altitude during the flight was about 103,000 ft. The XLR-99 again demonstrated its self-curing capabilities in restarting after a flame-out at the beginning of the flight. The *X-15* fell 8000 ft. while the automatic purge system cleared the engine for a second starting attempt. White experienced a full minute's weightlessness during the flight.

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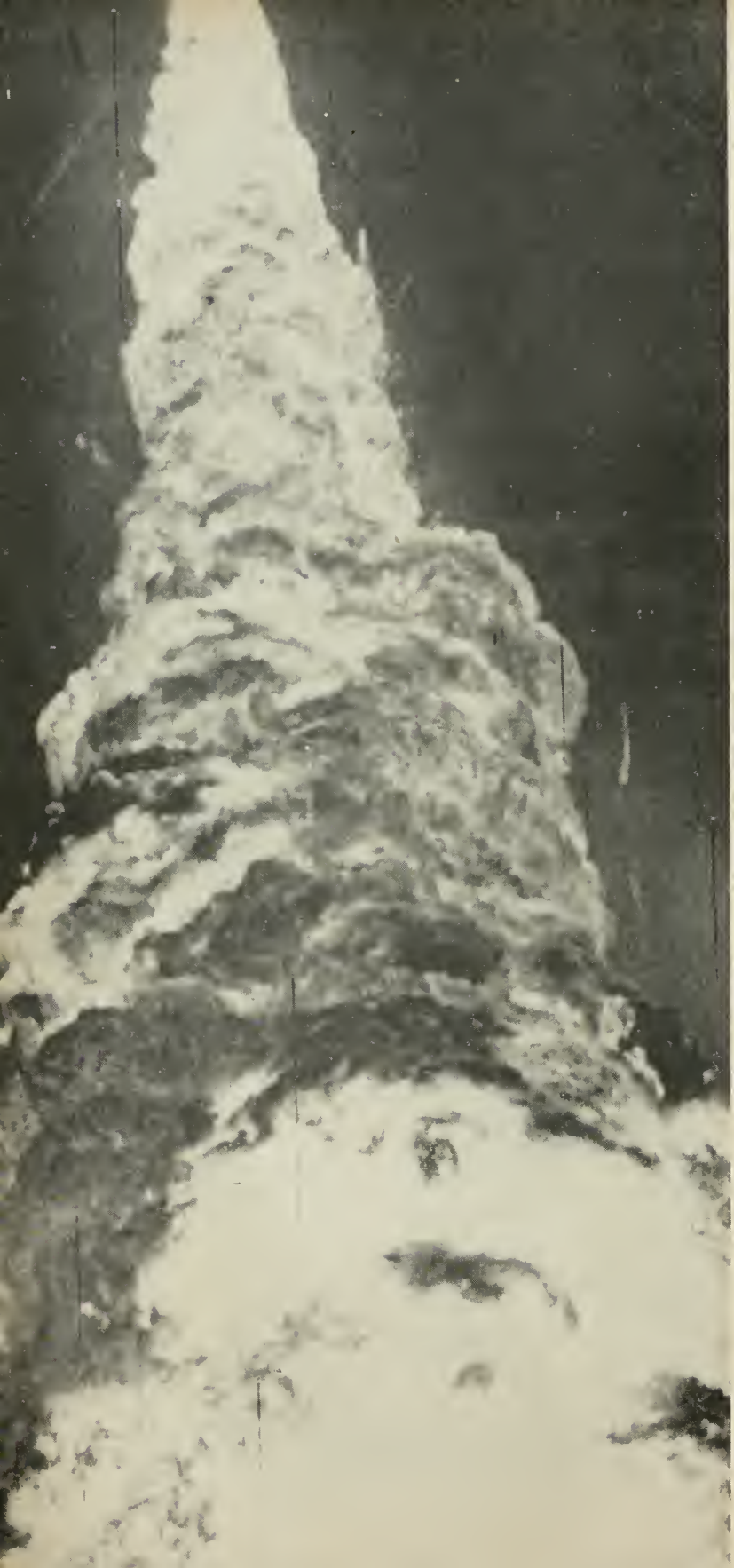


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ATLAS BOOSTER is exploded less than one minute after Mercury Atlas firing on April 25 when its programer failed.

Failure is spur . . .

Kennedy

Ways exist to give more funds to NASA, but basic question is whether U.S. will really enter contest

by James Baar

THE KENNEDY Administration is finally digging into the crucial question: Should the United States compete with Russia in the space race for the moon?

Despite many statements during and after the presidential campaign, the Administration did not begin seriously to face the more-than-three-year-old question until about a week after Russia orbited Yuri Gagarin around the world April 12.

Only now, with the latest *Mercury* failure as a new goad, is President Kennedy taking the space issue from the shelf.

Vice President Johnson, chairman of the all-but-staffless National Space Council, and his aides are conducting a rapid series of top-level discussions with military and civilian space officials and various technical experts. Johnson is expected to make recommendations to the President in the very near future.

How far Johnson may recommend that the United States go to match the Soviet effort—and what part of these recommendations the President will buy—remains to be seen. Since taking office, Kennedy has exhibited little enthusiasm for the space race.

• **Possible moves**—If Kennedy should decide to accelerate U.S. space efforts, he is considered most likely to:

—Make some adjustments in the NASA authorization bill now pending in Congress. The House Space Committee is expected to delay acting on the bill at least for a few days in hopes of including them. Otherwise, the increases would be inserted by the Senate Space Committee later.

—Make major adjustments by some transferring of funds already requested and by much faster spending of re-

Faces Decision on Moon Race

quested funds along with plans to submit a large supplemental money bill in January.

But the basic issue before Kennedy was not how he might find more money for space without making large increases in an unbalanced Federal budget. It was whether the United States was to enter the space race at all and, if so, how should it be done.

• **New blow to Mercury**—Meantime, the U.S. space lag was further emphasized by the NASA *Mercury* program's newest hitch—the flaming failure April 25 of an attempt to orbit an unmanned *Mercury* capsule for the first time.

NASA officials insisted that the failure, which was caused by the malfunction of the *Atlas* booster, would not affect the official *Mercury* schedule. However, this schedule with its goal of orbiting the first manned *Mercury* capsule before the end of the year has long been considered to have little connection with reality.

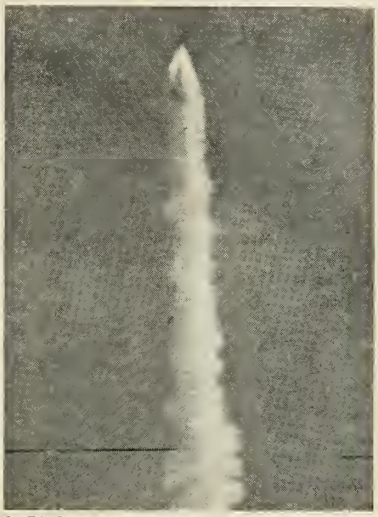
The first attempt to orbit a man has been expected to come about February or March at best. The latest failure was widely expected to cause the schedule to slip further.

Moreover, there was a nostalgic irony about the attempted launching on April 25, as well as the expected attempt to fire a manned *Mercury* capsule in a short ballistic flight down the Atlantic Missile Range about May 2.

• **Familiar pattern**—The White House has stood by while NASA made large-scale preparations for press coverage of both launchings—particularly the second. At no time has the White House seen fit to tell the general public that the relative significance of both launchings is considered by most experts to be very small in the overall East-West space race.

This is the pattern that the Eisenhower Administration established beginning in 1957. Major Soviet successes almost invariably were followed by widely-publicized U.S. efforts that top Administration officials did not bother to categorize in the context of Soviet accomplishments.

Kennedy announced even before taking office that he would put life into the never-used National Aeronautics



MERCURY ESCAPES from Atlas booster as big missile is blown up over the Cape.

and Space Council. He named Vice President Johnson as chairman instead of himself as stipulated under the National Space Act. The President affirmed that the council would have cognizance over all U.S. space programs under NASA or the Defense Department.

At this point, the interest of the Administration in space took a decided dip.

Some minor and decidedly uncontroversial legislation was needed to make Johnson chairman of the Space Council. This moved through Congress in a routine manner and did not emerge until April 21.

Kennedy is understood to have seriously considered adding little or nothing to the Eisenhower budget for space programs. In the end, he requested $125 million more for NASA and additional money for several military programs. But he rejected NASA requests for another $182.5 million and military requests for sizable funding for manned and unmanned offensive and defensive space systems.

• **"Scare figure" treatment**—NASA Administrator James Webb and other NASA officials repeatedly exhibited a less-than-eager attitude to challenge Russia's space lead and persisted in making the long-used NASA argument that the United States had a "solid step-by-step program designed to meet the needs of the country."

When several congressmen challenged NASA's interpretation of those needs, Dr. R. C. Seamans, Jr., associate NASA administrator, testified that it would cost between $20 billion and $40 billion to try to beat Russia to the moon.

Veteran observers of congressional hearings noted that Seamans had adopted what is known as the scare figure technique. This gambit—the use of a large and vague total—is usually employed to discourage congressmen interested in a program.

As late as April 21, Kennedy told a press conference:

"*Saturn* is still going to put us well behind. *Saturn* does not offer any hope of being first on the moon. *Saturn* is several years behind the Soviet Union and I can just say to you that regardless of how much money we spend on *Saturn* we are still going to be second.

"We have to consider whether there is any program now regardless of its cost which offers us hopes of being pioneers in a project. It is possible to spend billions of dollars . . . and still not be successful. . . . We have to make a determination whether there is any effort we could make in time or money which could put us first in any new area."

Kennedy's remarks indicated he was thinking only of space as a jousting ground for prestige. Nowhere in his remarks did he mention the military threat seen by many military men and feared by many in Congress.

Three days later the TV cameras were set up to record the launching of the first unmanned *Mercury* into orbit.

The lift-off of the big *Atlas* booster was normal. But after about 40 seconds of flight the range safety officer blew up the missile when its programer failed to operate correctly.

The escape rockets neatly carried the capsule clear. It descended by parachute into the Atlantic some 350 yards off the beach and was recovered by helicopter.

A NASA official said a man could have survived if he had been in the capsule. The launching was hailed as a splendid test of the capsule's escape rockets. ⌘

No Easy Cure for the Booster Gap

But many believe U.S. can have man on moon by 1965— if it will pay the price; ARC proposes new gel-solid propellant

INDUSTRY spokesmen are making it painfully clear to Congress that if the Kennedy Administration hopes to close the "Booster Gap" with Russia, it will find no quick and easy panacea.

However, there is a growing conviction in industry that with a massive—and costly—effort the United States could succeed in landing a man on the moon in 1965. This would be five to six years ahead of the most optimistic estimates under NASA's space program.

The problem boils down to one of accelerating development of liquid-fueled boosters—*Saturn* and *Nova*—and the parallel development of large solid rockets.

"It is my opinion that rather than not being able to afford parallel propulsion effort," Dr. Arch C. Scurlock of Atlantic Research Corp. told the House Space Committee, "our nation cannot afford to delay longer in undertaking this effort."

Scurlock, who disclosed to the committee a new ARC booster concept using a gel-solid propellant, was one of several witnesses testifying on what might be done to beef up the nation's large-rocket capability. In addition to a parallel solid-booster program, the ARC president recommended:

—Acceleration of *Saturn* and the F-1 engine for *Nova.*

—Acceleration of nuclear rocket propulsion and the advancement of high-performance liquid oxygen, hydrogen, and fluorine engines for upper stages.

—Money for programs which "bridge the gap between small-scale laboratory studies and large-scale hardware development."

• **"Last year's technology"**—On the latter point, Scurlock added:

"In this atmosphere of urgency, it is often too late to make the leap from small-scale laboratory results to full-scale application. In the absence of the required large-scale state-of-the-art work to demonstrate the full-scale feasibility of the new concept, it then frequently becomes necessary for us to employ last year's technology in tomorrow's space and missile systems.



TECHNICIAN fills container with ARC's gel-solid propellant.

"There is a lack of understanding of the value of this large-scale state-of-the-art work; and, consequently, funding to support this vital area has been inadequate."

Meantime, NASA officials indicated that supplemental *Rover* funds may be asked during the next fiscal year. Officials testifying on the R&D portion of the agency's FY '62 authorization bill said the start of work on a nuclear rocket engine prototype is presently keyed to the results of reactor tests to be conducted early next year. The new Kennedy budget omitted a request for $23.5 million to exploit any early favorable test results.

• **Potential debated**—Officials of both Aerojet-General Corp. and Grand Central Rocket insisted that large solid boosters were clearly possible, using segmented designs. Aerojet President Dan A. Kimball put a 30-month development time on a 17-million-lb.-thrust solid booster capable of pushing 7 million lbs. into space. He said a 2-million-lb.-thrust vehicle with a 1-million-lb. payload could be ready in 24 months.

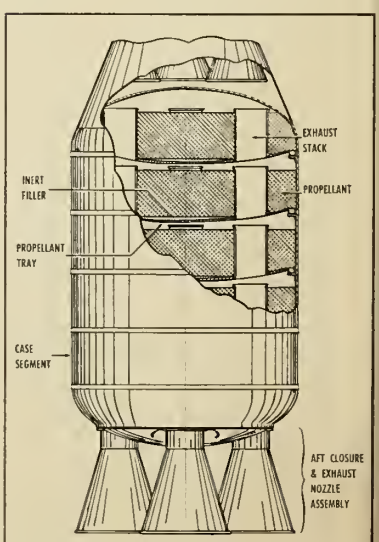
NASA, however, continued to take a sober view of the claims for solid boosters. Brig. Gen. Don R. Ostrander, head of the agency's launch vehicle operations, termed the claims "overly optimistic." But he said there is a definite need for $5 million to $15 million more to broaden the scope of tests in this area, an item trimmed by the Kennedy Budget Bureau. Any more, he contended, would be wasteful.

Ostrander declined to back the ARC gel-solid proposal, holding that there should be more study of these viscous-type fuels to determine whether they might contain too many disadvantages of both solid and chemical fuels.

ARC officials, however, maintained that the gel-solid was a "significant advance" in rocket technology. No details were given about the new propellant's chemical makeup, except that it had a specific impulse in the 250 range.

The propellant is a slurry of toothpaste consistency, containing metal powder and oxidizer dispersed in a liquid carrier and gelling agent. It is manufactured in a conventional solid-propellant mixer. Tests have shown that it can be stored 18 months or more — perhaps indefinitely — without deterioration.

Prior to developing the concept,



ARC said, it used the propellant as a liquid monopropellant rather than as a solid.

The gel-solid would offer the advantage of being pumped like a liquid into "trays" inside the rocket directly after mixing. Casting and curing steps required for a solid would be eliminated, since no polymerization or solvation is necessary.

In its materials testing program, from which the concept originated, ARC said it had successfully fired nearly 100 gel-solid motors with 100% ballistic reliability.

Two designs put before the House Space Committee were for a 1-million-lb.-thrust and a 4-million-lb.-thrust motor, each with a burning time of 45 secs. The first motor would be 10 ft. in diameter, have a propellant weight of 182,000 lbs. and a gross weight loaded of 216,000 lbs. Propellant mass fraction would be 0.84. The larger motor, 20 ft. in diameter, would have a propellant weight of 686,000 lbs., a gross weight loaded of 827,000 lbs., and a mass fraction of 0.83.

Company officials contended that the lower mass fraction resulting from a heavier hardware design would be "more than compensated for" by a decrease in the vehicle's cost and in system simplicity.

One of the big weight factors is the tray structure to hold the fuel. A "stove pipe" for gas flow to the nozzle passes through each one of these propellant beds. This insulated standpipe is similar to commercial distillation columns used by the chemical industry and, in the opinion of ARC, would be well within present technology.

The tray system would permit much the same flexibility as a segmented solid booster, since they, too, could be segmented or clustered to deliver specific amounts of power for space missions.

However, the gel-solid would be most practical in the multimillion-lb.-thrust range because of the low mass fraction.

• **Quick development**—Trays would be loaded by extending a boom up the exhaust stack after the rocket had been assembled on the launching site. The boom, which has a nozzle at its tip, is coupled to a pump system to carry the propellant from a tank car. Loading is controlled by positive displacement measure and a level control within each tray.

ARC believes that within a year it could demonstrate initial feasibility at a cost of $1.5 million.

"In the ninth month," a company spokesman said, "a decision would be required to initiate development of one of these motors.

"If the 1-million-lb. (motor) is selected, development to the point of flight testing would be carried out between the 9th and 25th months.

"Development of the 4-million-lb. motor, if selected in preference to the smaller engine, would be carried out between the 9th and 30th month, to the point at which a program could be begun to demonstrate flight capability."

Cost of showing flight capability of the first motor would be $12 million and for the second, $28 million. No estimate was given for overall development of the system.

• **All-solid proposal**—Grand Central Rocket's Dr. Cledo Brunetti renewed arguments before the committee for moving now into a large solid booster program. Advancing "building block" concept, the GCR president displayed plans for a six-segment motor with an overall length of 138 ft. and a diameter of 13.5 ft. A lunar launch vehicle for a 130,000-lb. spacecraft would require a cluster of five of these motors in the first stage; a four-segment motor 100 ft. long and also 13.5 ft. in diameter would be bundled in a cluster of four for the second stage. Thrust of the first stage would be approximately 19.3 million lbs. and the second stage would be approximately 10.3 million lbs.

Third and fourth stages of the vehicle would be similar to those being designed for liquid-fueled *Nova*.

Taking a "hypothetical" liquid-fuel rocket for sending a 160,000-lb. spacecraft to the moon, Brunetti estimated it would cost $2 billion through the proof flight phase against $1.32 billion for the GCR segmented solid. First operational flight could be in 1965.

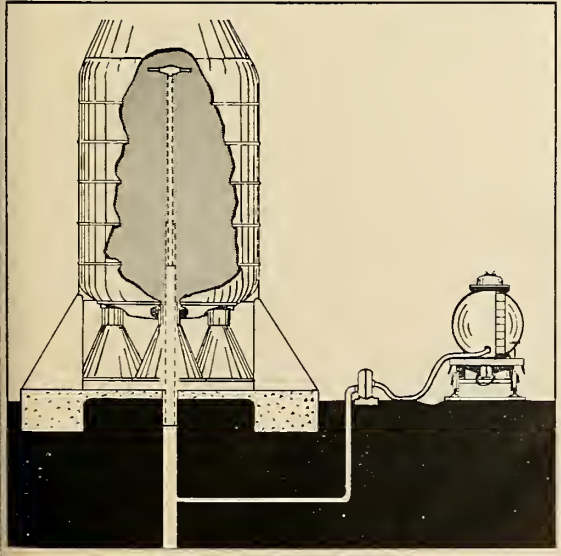
He said cost figures included such items as launch operations, Atlantic Missile Range instrumentation facilities, GSE, design and fabrication of handling, transport, and launch check-out equipment—besides the manufacturing cost of the motors, development and test of interstage structures, vehicle design and assembly.

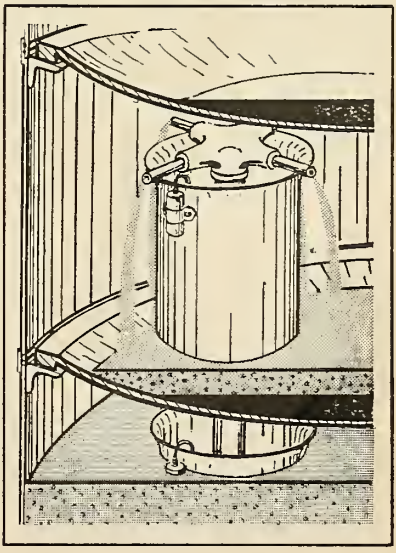
The GCR proposal, which features a nozzle with two jet vane controls, would require no technological breakthroughs. Said Brunetti:

"The nozzle, although larger than existing designs, is a logical scale-up from successful nozzles of the same type."

It would be about 8 ft. in diameter. Propellant, while not specified, would be rubber-based of conventional manufacture.

Looking at the long range costs, Brunetti said 100 payload flights of a solid booster would cost $4.6 billion, or $702 per lb., against $6.8 billion, $1040 per lb. for an all-liquid rocket ⁂





FAR LEFT: *Typical design features of ARC segmented gel-solid booster concept.*

LEFT: *Propellant is pumped from tank cars or underground storage tanks to telescopic loading boom buried in caisson beneath launch pad.*

RIGHT: *Pressure-actuated telescopic nozzles in loading-boom head project radially to deliver propellant over lip of exhaust stack.*

Koelle cites handicap . . .

Space Effort Hurt by Slow Decisions

NASA future projects chief fears Soviets have taken lead in developing clustered engines despite head-start by U.S.; best bet now is in earliest possible flights of Saturn C-2

by Jay Holmes

HUNTSVILLE, ALA.—America has the technical ability to beat Russia to the moon but its decision machinery is probably too slow, a long-range planner asserts.

Heinz H. Koelle, Chief of Future Projects for the Marshall Space Flight Center, National Aeronautics and Space Administration, maintains that a decision takes only four weeks to proceed from the technical level in Russia to final approval by Premier Khrushchev. In this country, Koelle commented, the decision can require a year or more.

Koelle has reason to question America's ability to make up its mind. In late 1957, he was one of the first to propose the clustered engine idea from which emerged the *Saturn* booster program. More than two years went by before the project gained top national priority as part of an effort to surpass the Soviets in rocket power.

Although he believes this country started its clustered engine project ahead of Russia, Koelle fears Russia has already pulled ahead—as a result of early U.S. indecision—in the race to build the next-generation booster.

The 36-year-old Koelle, a former Luftwaffe fighter-bomber pilot who joined Wernher von Braun's U.S. team in 1955, figures that Russia is clustering an engine of about 500 metric tons (1.1 million lbs.) thrust. A cluster of eight thus would generate 8 to 9 million lbs. thrust—enough for a *Nova*-type booster for a manned lunar landing.

• **Money no answer?**—Koelle doubts that the U.S. could beat Russia in developing a *Nova* vehicle, even if unlimited funds were made available tomorrow. The only hope he sees is in orbital operations based on the *Saturn C-2*. However, he proposes that *Nova* be developed as a backup.

The Marshall Center future planner does not claim to have definite information on Russia's plans. But he says a 500-metric-ton engine is a logical step up from the 100-metric-ton engine of the Soviet ICBM. And as for clustering, he argues that Russia had ample opportunity to observe how its feasibility was demonstrated in this country.

High hopes are held here for nuclear upper stages, together with the *S-I* and *S-II Saturn* stages. But Koelle voices doubt that the vehicle—designated *Saturn D*—will be reliable enough for use by men in the 1967 period now being discussed as the goal of any all-out effort to land a man on the moon.

Koelle and an assistant, 32-year-old Harry O. Ruppe, see the *Saturn*-nuclear vehicle as a low-cost ferry that would carry supplies in support of a lunar base.

The first manned lunar mission, Ruppe maintains, would be powered by a hydrogen-oxygen rocket, roughly the same size as the *Saturn S-IV*, boosted empty into orbit and filled with LOX and LH2 boosted by six or seven subsequent *Saturns* and fueled by rendezvous.

• **Two-test plan**—Lockheed and Space Technology Laboratories are studying how orbital transfer techniques might be perfected with the use of *Atlas-Agena B* vehicles. The next step, Ruppe said, should be the launching of two satellites to test the Lockheed-STL method. He sees two possible flight tests. One would comprise two separate launchings, using ground data on the first to actuate guidance and control of the second. The other would involve launching two satellites with one vehicle, after which the two orbiters would be successively separated and again brought together.

In both possible tests, the final correction would be accomplished by cold-gas jets. Ruppe regards the orbital technique as essentially an automatic operation, although it could be man-operated later on.

Koelle and Ruppe maintain that reliability through experience will be the compelling advantage of using *Saturn C-2* if the earliest possible flight is made a national goal. The *Nova* vehicle is unlikely to be man-rated by the 1967 period, they argue.

• **Hope for Nova**—However, Ruppe hasn't given up all hope on the *Nova*. He notes that a breakthrough has developed in the last year in segmented solid boosters. If further breakthroughs take place in solids, he says, it may be possible to shorten the vehicle development time enough so that a solid-boosted *Nova* might be competitive.

In any case, Marshall Center planners contend that orbital operations must be developed because of their absolute necessity for manned planetary flight. They foresee a three-phase supply line between the surface of the earth and that of the moon. First phase would be a chemical booster—*Saturn S-I* and *S-II* in its early period—to lift payloads from earth to earth orbit.

The second phase would be a *Nerva* nuclear rocket for ferrying payloads between earth orbit and lunar orbit. The final phase would be an *S-IV*-type rocket for landing on and boost from the lunar surface. About ⅔ of the *S-IV* propellant would be consumed on landing. The remainder would be sufficient to lift back into orbit.

The same three-phase operation would apply for interplanetary transportation, Ruppe adds, but the orbit-to-orbit second phase would be nuclear-electric propulsion.

When the lunar supply system swings into full operation, all vehicles would be reusable many times and the cost would go down to $150 or $200 a pound delivered on the lunar surface. The *Saturn S-I* stage would be recovered by use of a Rogallo Paraglider.

Recovery of the *S-II* stage would be a much more tricky operation. One method Ruppe sees possible is to let the *S-II* coast up to orbital altitude by Hohmann Transfer Ellipse, reaching apogee at exactly 180 degrees away from the launch point. The payload would separate with a small propulsion stage that would provide about 350 ft./sec. velocity increase to kick it into orbit.

After separation, the empty *S-II* would coast around to re-enter 1500 miles west of the launch site. Re-entry might be accomplished with a combination of drag brake and a Rogallo Glider. ⌘

Chimps Will Be Orbited for Weeks

CHICAGO—The Air Force is planning a series of animal biomedical space flights aimed at putting a 50-lb. chimp in orbit for 14 days.

First passenger will be a 6-8 lb. Rhesus monkey traveling piggyback in an especially designed re-entry pod on a routine suborbital *Atlas* test shot. The Air Force has also disclosed that it will use a Lockheed-built Advanced Biomedical Capsule *(ABC)* to orbit large chimpanzees for several weeks at a time. This program is called the Bioastronautical Orbital Space System (BOSS).

The existence of the two programs was confirmed at the thirty-second annual meeting of the Aerospace Medical Association held here last week.

The *Atlas* passenger pod, in which a small monkey will be carried sometime this year, is a cylinder 30 in. in diameter and 102 in. long. It is attached to external weldments on the missile sustainer section, and located radially between vernier engine number 2 and the B-1 missile equipment pod.

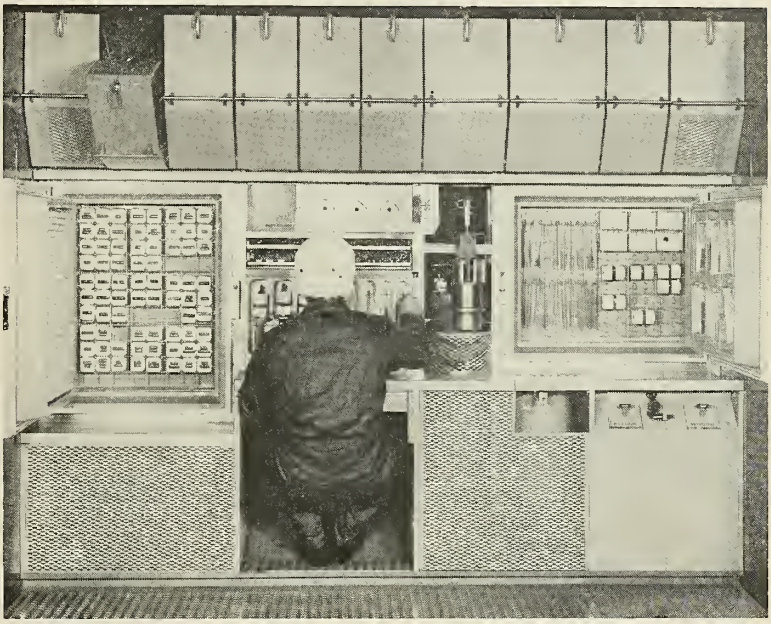
Some 30 seconds after the sustainer engine cutoff, a programer will automatically eject the pod. With the North American Aviation animal capsule inside, it will follow a ballistic trajectory paralleling the missile and impacting in the recovery area. The pod is provided with a blunt nose fairing with ablative material for re-entry, and will be recovered.

Object of the test will be to demonstrate the feasibility of an internal physiological telemetry system. The Spacelabs, Inc., FM/FM system will telemeter respiration (low frequency), electrocardiogram (medium frequency) and phonocardiogram (high frequency).

This type of internalized animal instrumentation will also be used in the BOSS program, an Air Force spokesman said, and ultimately may lead to its use in humans.

• **Spacelabs' system**—The internal system consists of two pressure sensors and a pair of ECG electrodes, three subcarrier oscillators, a rechargeable single Ni-Cd cell, an RF oscillator and a recharging coil.

The output signals of the three subcarrier oscillators are mixed and the resulting voltage used to modulate the 45 megacycle RF oscillator, which is located in a separate package. The signals are transmitted to a receiving antenna in the animal support couch and directed to a small FM receiver.



WHIRLPOOL SPACE KITCHEN mockup is designed for three-man, 14-day orbital journey. Canned and dried foods are stored in pull-down bunkers along top; freezer contains racks of bite-size sandwiches. Three-cavity heating oven in center will heat canned foods. Cold-water nozzle is at spaceman's right. Entire kitchen, designed for Aeronautical Systems Division, AFSC, weighs 818 lbs., is 10 ft. long by 7½ ft. high, and occupies 106.06 cu. ft.

The video output of the receiver is connected to a three-channel discriminator where the sub-carrier frequencies are separated from the composite signal by band-pass filters. The individual subcarriers are discriminated separately to recover the modulation frequency components. The three signals are filtered with low-pass filters, to remove the subcarrier frequency components, and presented in analog form for retransmission. This makes the system self-sufficient during countdown, when the pod telemetering system is not operating continuously. The pod telemetry is provided by Convair-Astronautics.

• **New human restraint system**—Another significant feature of the medical association meeting was the introduction of a new concept in restraint systems designed to replace the restraining couch.

The portable system, introduced by NASA's Ames Research Center, need not be tailored individually, as were the *Mercury* couches, and it can be stored out of the work area for most of the trip.

Ames' representatives said the system is effective for any combination of accelerations, including "eyeballs in" ($+A_x$ or forward), "eyeballs out" ($-A_x$), and "eyeballs down" (A_N). The concept was tested at both the Johnsville and Aerospace Medical Lab centrifuges; loads of 7, 10 and 12 g's were sustained with favorable results.

The restraint system is basically a suit employing inflatable bladders and harnesses. Lightweight shells, made of aluminum and Fiberglas, cover the bladder system. Although air has been used until now to inflate the bladders, NASA said that later oil or a plastic foam might be used instead, to minimize rebound characteristics during high impact.

An airtight, intricately engineered helmet designed by Protection, Inc., carries the only portion of the suit which must be individually tailored. This is a facial insert, constructed of polyurethane foam, fitting the features of each pilot. The insert would crush only at a loading of about 50 lbs. psi, thus affording excellent impact acceleration protection. ⌘



SEATTLE—A 400-mile-range Bomarc B is readied for testing at Boeing Missile Production Center. The Air Force authorized Boeing to begin production of advanced Bomarcs last year. They will be deployed at three U.S. bases and two in Canada.

U.S. Beefs Up Bomarc Protection

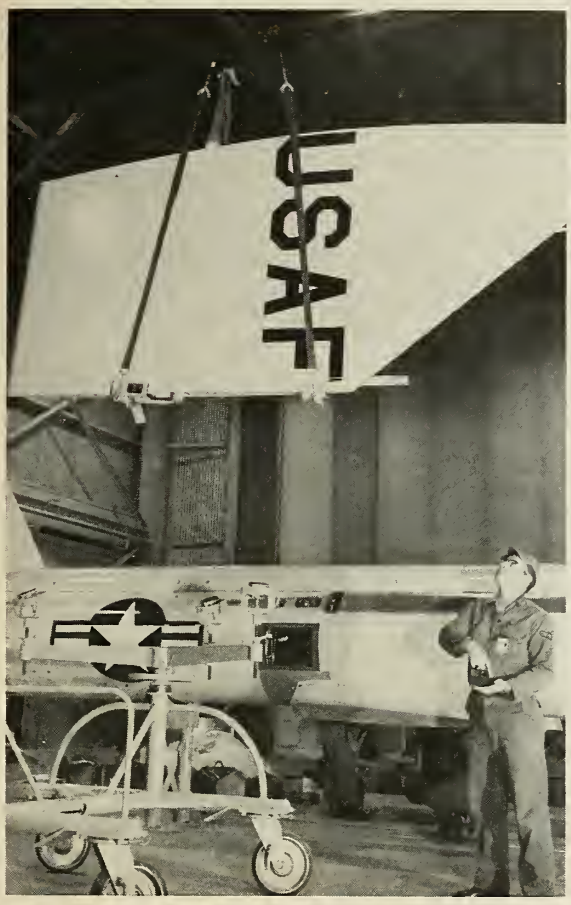
FIVE BOMARC A bases scattered from Maine to Virginia today guard the Northeast from air attack. Meantime, test launches of the advanced *Bomarc B* and training launches of *Bomarc A's* continue at Eglin AFB, Fla. The 400-mile range *Bomarc B's* will be deployed along with the 250-mile-range *Bomarc A's* already on alert at McGuire, Otis and Langley Air Force Bases. *Bomarc B's* also are scheduled to be deployed at Niagara Falls, N.Y.; Duluth, Minn.; Kincheloe AFB, Mich.; North Bay, Ont., and La Macaza, Quebec. ⌗



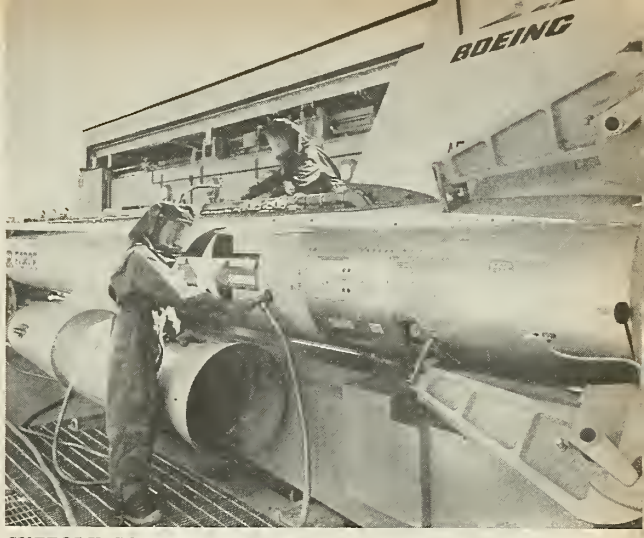
McGUIRE AFB, N.J.—One of nearly 60 Bomarc A's at instant readiness at McGuire is moved into firing position.



EGLIN AFB, FLA.—Missilemen check Bomarc A ramjet before a training shot over the Gulf of Mexico range.



OTIS AFB, MASS.—A Bomarc A wing is lowered for installation on missile following periodic checkout in MAB.



SUFFOLK COUNTY AFB, N.Y.—Bomarc A booster is fueled with JPX and red fuming nitric acid.



DOW AFB, MAINE—Twenty-eight launchers house Bomarc A's ready for action over a 196,000-sq.-mi. area.



LANGLEY AFB, VA.—Readiness check is performed on Bomarc A's. Missile ramjets stand on skids while checks are conducted. Once the missile is on its launcher, Bomarc firing is automatic—commanded from SAGE missile center miles away.

We promise you a reply by telephone or wire within 48 hours after receipt of your inquiry!

new openings in space age electronic projects

Hughes Aerospace Engineering Division offers experienced graduate engineers and physicists a choice from nearly 100 openings on Hughes projects which include:

- Digital Computer for Polaris Guidance
- Infrared Applications for ICBM Surveillance
- Space Ferry
- Satellite Communications
- Pulsed Doppler Radar for Anti-Submarine Warfare
- Advanced Air-To-Air Missiles
- Automatic Check-Out Equipment
- Space Radiation Measurement and Detection

Training and experience should be applicable to the research, development, design and testing of advanced electronic equipment for use in space vehicles and supersonic military aircraft; in solid state physics, nuclear electronics, industrial dynamics, and related areas.

Use of the following form will, we hope, reduce to a minimum the inconvenience of submitting an employment inquiry, yet will still permit us to give you a reasonably definitive reply.

Please airmail resume to:

Mr. Robert A. Martin, Supervisor, Scientific Employment
HUGHES AEROSPACE ENGINEERING DIVISION
Culver City, California

HUGHES
HUGHES AIRCRAFT COMPANY
AEROSPACE ENGINEERING DIVISION

NAME_____

ADDRESS_____

CITY_____ ZONE_____ STATE_____

COLLEGE_____ DEGREE_____ YEAR_____

I am interested in one of the following types of assignments:

☐ RESEARCH	☐ PROTOTYPE DESIGN	☐ SYSTEMS ANALYSIS	☐ OTHER:
☐ DEVELOPMENT	☐ ADVANCED TECHNICAL PLANNING	☐ SYSTEMS DESIGN	☐ _____

I have had professional experience in the following specific areas:

☐ CIRCUIT ANALYSIS AND DESIGN	☐ STRESS ANALYSIS	☐ R-F CIRCUITS	☐ ELECTRO-MECHANICAL DESIGN
☐ DIGITAL COMPUTERS	☐ INDUSTRIAL DYNAMICS	☐ RELIABILITY	☐ OTHER:
☐ GUIDANCE DEVICES	☐ INFRARED	☐ INERTIAL GUIDANCE	☐ _____
☐ MICROWAVES	☐ SYSTEMS ANALYSIS	☐ INSTRUMENTATION	☐ _____

I have had a total of_____years experience.

Technical Countdown

SUPPORT EQUIPMENT

3-D Viewer Needs Cut to One

A single depth-indicating display, instead of the usual two, has been demonstrated by Hughes Aircraft Co. for use with its three-dimensional "Frescan" radar system. Believed to be ideal for surveillance as well as air traffic control, the stereoscan display permits easier reading, higher accuracy and daylight room lighting, says Hughes. Relatively inexpensive, the unit also provides "electronic contrails" to aid in following multiple targets.

New Radar Targets Used Successfully

Balloon-borne 6-in. aluminum spheres are being used by Sperry Gyroscope to test missile tracking radars. Suspended from small inflated bags, the one-dollar-apiece targets are now being used primarily to check guidance and as target-tracking radars for the Navy's *Terrier* and *Talos* missiles.

Super Insulators Operating at Cutler

World's biggest radio-antenna insulators are now in use at the Navy's VLF transmitting station in Cutler, Maine. Built by General Electric in Baltimore, the six insulator bushings stand 26 ft. high, weigh 8500 lbs. and will carry up to 300 kv. The unit is corona-free at 500 kv, 60 cycles a-c. Sulfa-hexafluoride is used for insulation in the conical structure.

Big Dish for Space Work

Lincoln Laboratory at MIT and North American Aviation are building a super-precise 120-ft. paraboloidal reflector for the Air Force. To be used for global communications and space studies, the dish surface is held to a tolerance of 0.076 in. Housed within a 150-ft. Fiberglas and aluminum radome, the structure is part of a $3.8-million research facility to be completed by late 1962. It will operate at 10 gc with a beam width of 1/20 degree.

ELECTRONICS

Military/Industrial Electronics Up

Total electronic components shipped during fourth quarter 1960 increased 4%, the Commerce Department reports, while the total for the year was 10% over 1959. Increase was due solely to military/industrial requirements, since consumer needs dropped significantly.

More Reduction in Atlas D Guidance Weight

Atlas D radio guidance system transponders have been vastly reduced in size. The new unit weighs 12 lbs. compared with earlier versions which checked in at 88 lbs. This is in line with the reduction in weight of the guidance system itself, which has been reduced from 244 to under 33 lbs., according to General Electric.

Optical-Frequency Computers Next?

A leading optical manufacturer has told TECH COUNTDOWN that a hybrid optical/microwave computer can be developed in from 10 to 15 years. The system would offer high capacity with greatly reduced size and would employ optical logic components. The prediction is based partly on great strides in fiber optics developments.

NORAD Seeks Automated Center

Seventeen firms have been asked for proposals for an automated combat operations center for the North American Air Defense Command. Scheduled to be opened June 1, the proposals will lead to a development-production contract for the NORAD center, to be located near Colorado Springs.

Thermionic Power Contract for Mariner

NASA's Jet Propulsion Laboratory is expected to award a contract soon on a thermionic power supply for the *Mariner* interplanetary probe. It requires output of 130 watts from a solar collector 5 ft. in diameter.

Compact Package Stores Space Antennas

Experimental models of antennas that can be packed into containers about the size of box cameras, and then expanded on command to full-sized arrays, have been delivered to the Air Force Systems Command (AFSC). Designed by Lockheed and Schjeldahl, the antennas can be erected by mechanical or pressure techniques after the carrier vehicle gets into orbit. The devices are expected to be used in satellite-to-satellite communications and weather mapping.

ADVANCED MATERIALS

Boeing Markets Furnace Development

A fluidized bed furnace for heat-treating super alloys and exotic materials which maintains a temperature stability within 2° over a 2000° range will be marketed by Electric Furnace Co. under an agreement with Boeing Airplane Co. High thermal conductivity is attained by the violent movement of tiny refractory particles.

Liquid Hydrogen Laboratory Completed

Douglas Aircraft opened a $450,000 liquid H_2 laboratory to handle the testing demands of the *Saturn S-IV*, hydrogen-oxygen engines. Leak, flow, dynamic, thermal shock, life cycle, altitude, vibration and burst testing runs on system components will be scheduled at the facility.

Air Force Seeks Blast Off Silencers

Additional studies on deflector-diffusers to estimate and minimize the noise environments at future rocket sites are recommended in an Air Force report. The study used a series of standard 1000-lb.-thrust JATO rockets and six scale-model blast deflectors. Special problems created by the acoustical energy of blast-off include fatigue and failure of structural materials malfunction of electronic assemblies and personnel exposure.

PROPULSION

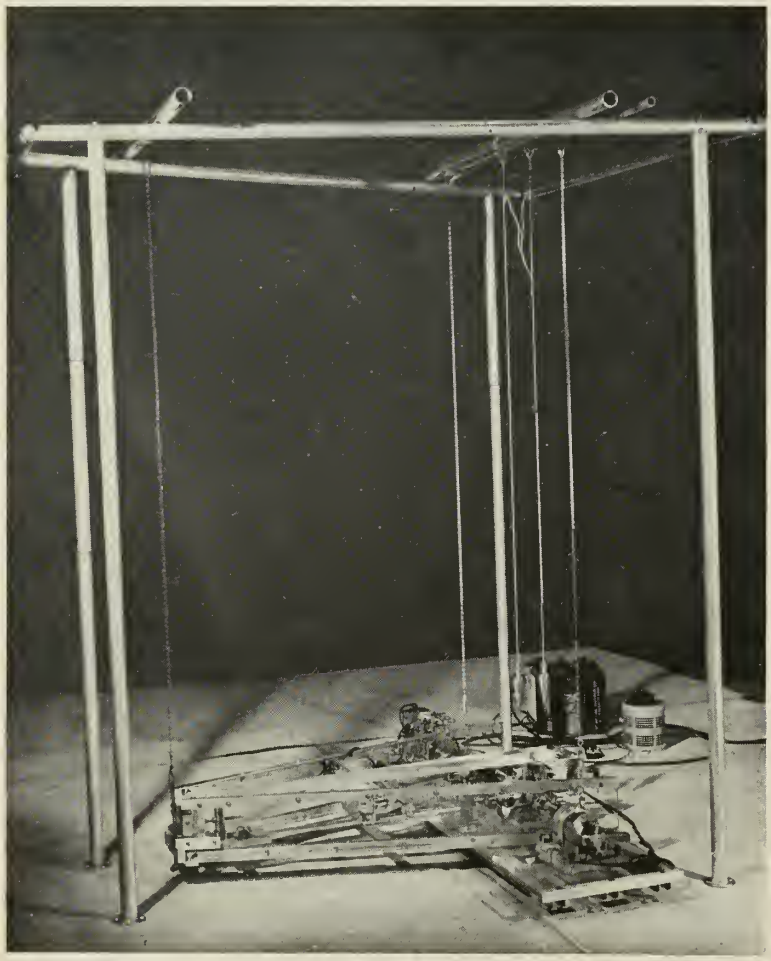
Production-Processing Solid Propellants

Demonstrating Rocketdyne's continuous method for making solid propellants—the Quickmix method—a nonstop record of 11 consecutive propellant processing runs was set at the company's McGregor, Tex., plant. Compared with the identical propellant mixed by the conventional batch method, the Quickmix propellant showed "better distribution of ingredients, closer uniformity between individual propellant runs, and greater density," according to the company.

The Controversial Dean System Space Drive

Startling patented system converts rotary motion into one-direction thrust; practical machine still to be made

by Charles D. LaFond



DEAN SYSTEM Space Drive concepts have been demonstrated with this proof-of-principle device. System shown is completely suspended, yet with a small motor as prime it moved a 50-lb. dead load on the floor about 2 inches.

A TRANSMISSION system has been developed to convert rotary motion into unidirectional thrust without the system itself being acted upon.

Through the use of oppositely rotating pairs of eccentric inertia masses, the freely suspended system converts the movements—provided by a prime mover—into either intermittent propulsive pulses or continuous thrust in one direction.

When a load is imposed on the system in a central position so that movement in one direction will act on and move the load (a clutch prevents slippage during negative oscillations), lift or thrust is accomplished.

This essentially is the functioning of the Dean System Space Drive. Exactly how this occurs—or even if it occurs—is the subject of growing wonderment in scientific and engineering circles.

Invented by Norman L. Dean of Washington, D.C., the system has been patented in the United States, England, and Italy.

For well over a year, Dean has pounded Washington doors of the military and the National Aeronautics and Space Administration, desperately seeking technical and contractual support.

The doors at NASA are reported to be securely bolted against his intrusions.

Those of at least one branch of the military have been opened, reluctantly —so far only for conversation, although a study contract may eventually result.

In industry, those few who have been exposed to a Dean exposition have on occasion gone so far as to offer an easy chair and begin talking franchise terms. When this has happened, Dean apparently has slammed the door himself.

Nineteen different claims are established in Dean's basic system patent. All refer to lift or drag-type devices, and are essentially anchorless winches.

A typical simple system employs one pair of eccentric counter-rotating inertial masses fixed on parallel drive shafts. Primary rotary power is mechanically connected to one; the other is driven by gears.

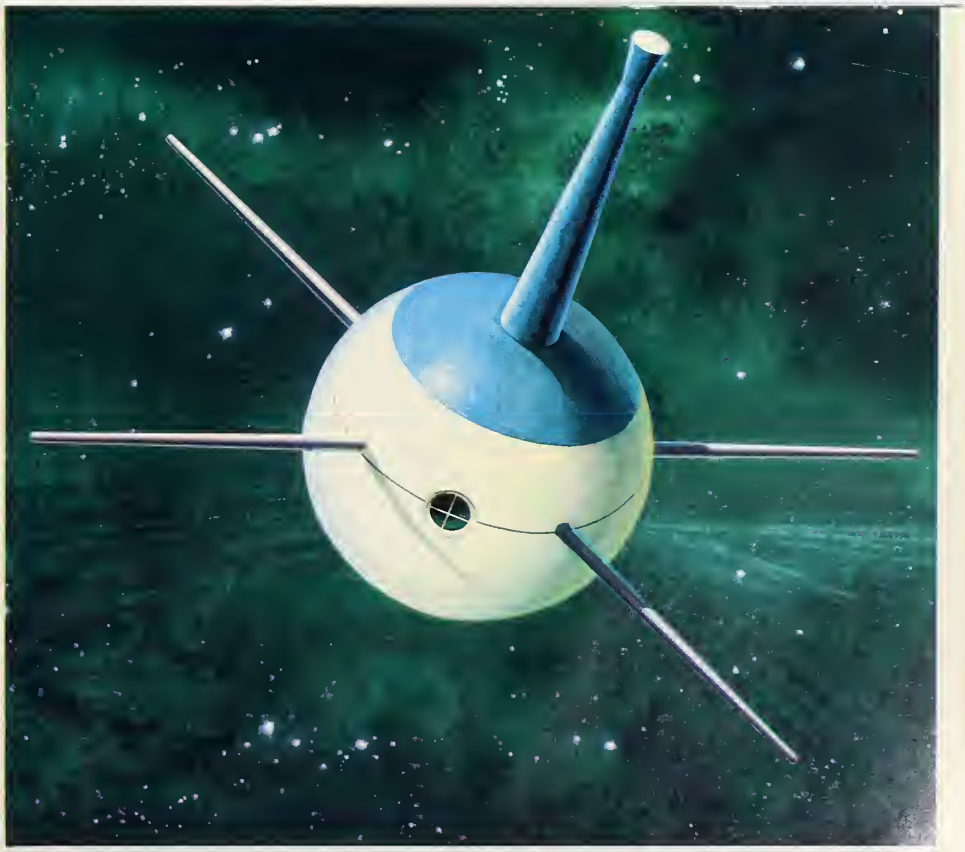
The frame supporting the two eccentric-mass shafts is supported above and below with adjustable springs; thus the frame is freely suspended in one plane within an outer frame. Rollers, wheels, or bearings permit minimum friction between the two frames. A pair of solenoids return the movable frame to the center position during each oscillation, and provide damping.

A steel tape operates as the load mechanism, and during each positive position of an oscillation it is advanced by an engaged electromagnetic clutch.

(Continued on page 34)

VANGUARD

Space Exploration



Honeywell Inertial Reference system provided guidance into precise orbit.

H HONEYWELL

DISCOVERER

Defense

Honeywell Inertial Reference system on Agena B stage for guidance into and during orbit.



TIROS

Meteorology

Honeywell Inertial Reference system on Delta stage for launch guidance.



MIDAS

Defense

Honeywell Inertial Reference system for Agena B stage programmed for Midas requirements and Thor vehicle.



X-15

Manned "Edge of Space" Flight

Honeywell Adaptive Automatic Flight Control System integrates reaction jet and aerodynamic controls.



SCOUT

Space Exploration

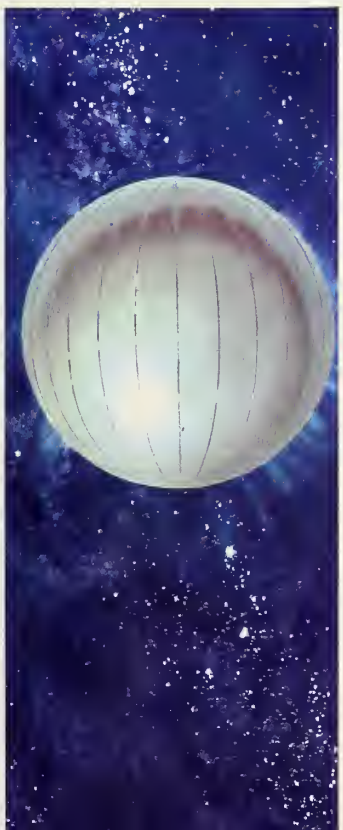
Honeywell Guidance and Control System for all four stages and GSE for this equipment.



ECHO

Communications

neywell Inertial Refer-
e system on Delta
ge for guidance into
cise orbit.



MERCURY

Manned Flight

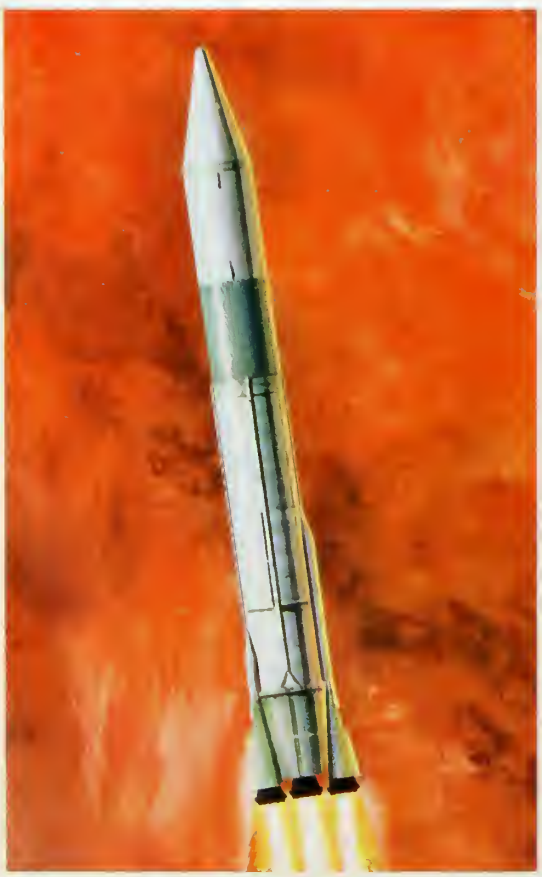
Honeywell Automatic Stabilization and Control System; Attitude and Rate Indicating System; Earth Path Indicator; and Humidity Indicator.



CENTAUR

Space Exploration

Honeywell Digital Inertial Guidance System provides vehicle launch guidance and space navigation.



ADVENT

Communications

Honeywell Inertial Reference system on Agena B stage for guidance into and during orbit.



MARINER

Space Exploration

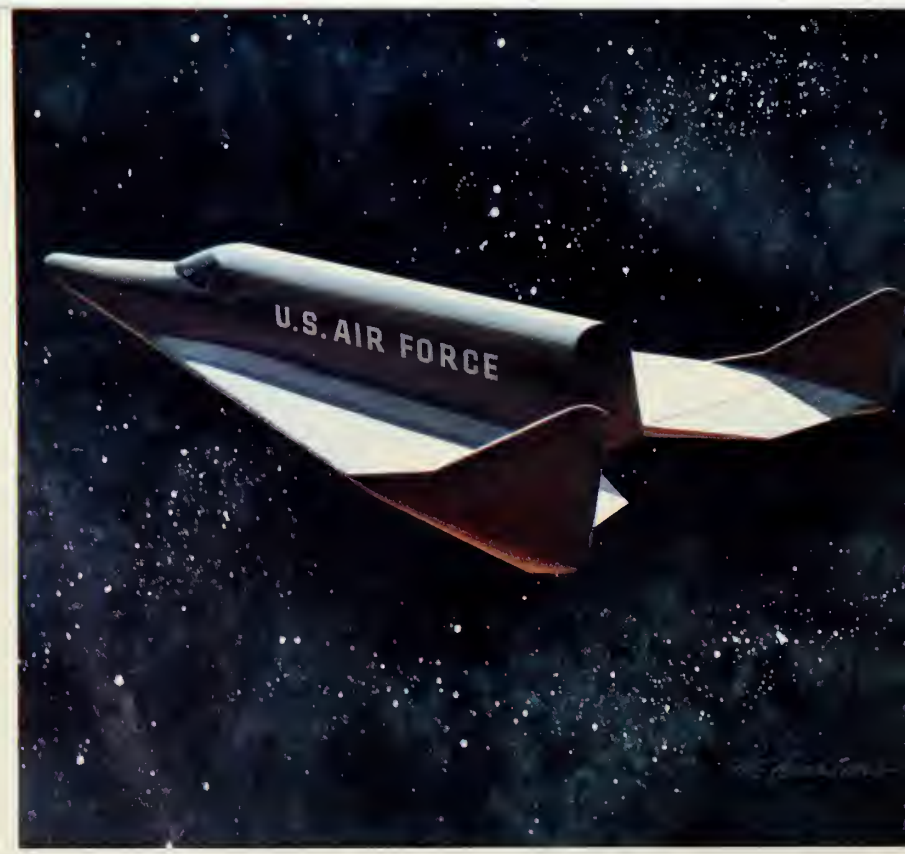


Honeywell Inertial Reference system for Agena B stage.

HONEYWELL

DYNA SOAR

Manned
Maneuverable
Space Flight



Honeywell Inertial Navigation System and Flight Control Subsystem Electronics for the spacecraft and Inertial Reference system on Titan booster for launch guidance.

FROM
VANGUARD TO DYNA SOAR

Honeywell's experience in guidance and control systems spans the space age

The space age is only three years old, but the companies responsible for the spectacular advances during this short period qualified for their space assignments by virtue of extensive prior experience and knowledge. Honeywell, for example, had been designing and producing automatic flight control systems for over fifteen years when it was selected to develop the inertial reference system for Vanguard I. A number of Honeywell flight control systems were "firsts"—electronic (for the B-17), supersonic (for the F-100) and adaptive (for the X-15).

Honeywell inertial reference systems or precision floated gyros have guided 30 of the 39 satellites the U.S. successfully placed in orbit. Vital contributions have been made to space exploration, space communications, meteorology, missiles, and manned space flight. Honeywell's role has been extended to systems responsibility on some of the most sophisticated space projects. In every case, Honeywell's contribution has been backed by the full scope of scientific skills and production facilities required to do the job. Illustrated on the pages below are examples of Honeywell's proven capability . . . from Vanguard to Dyna Soar.

SPACEABILITY—THE CASE FOR HONEYWELL SYSTEMS RESPONSIBILITY

Guidance and stabilization, environmental control, and instrumentation—all essential to space operations—are Honeywell specialties, stemming from Honeywell's 76 years of experience in automatic control.

Honeywell's Military Products Group, staffed with 11,000 employees (2,000 of whom are professional engineers), occupies over two million square feet of facilities in eight cities. Honeywell's fifteen other divisions and the experience of their 29,000 employees, form an immense reserve in research and production facilities which the Military Products Group draws upon for special support. All of these varied resources are coordinated on Honeywell systems management contracts. To learn how Honeywell can assist you in your space programs, contact your local Honeywell representative, or write: Honeywell, Aeronautical Division, 2600 Ridgway Road, Minneapolis 40, Minnesota.

Honeywell

H HONEYWELL Military Products Group

(Continued from page 24)

There are various methods of timing and controlling the activation of the solenoids and magnetic clutch.

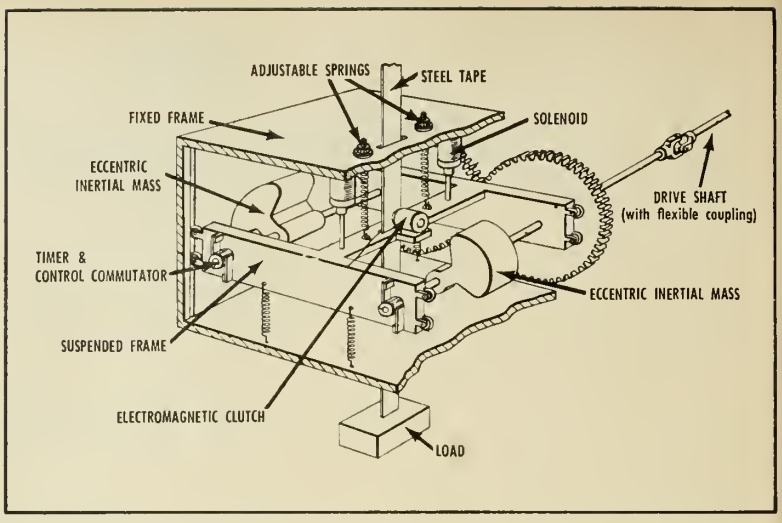
A gravitational load held against back movement requires no coupling following each cyclic advance. When the system is used as a lift, however, some form of mechanical clutch must be employed to hold the load attaching member during negative movements of the drive mechanism.

Dean maintains that during operation of the counter-rotating eccentrics the heart of the system is the intricate phasing relationship which must exist. The rigid connection between paired shafts and the counter-rotation of masses produces a cancellation of forces and reactions engendered in all directions except in the direction of the desired oscillation. This is always parallel to a plane perpendicular to the axes of rotation of the two masses.

The outgrowth of the cancellation is an oscillation produced by the resultant forces which represent the sum of the components of all forces acting in the direction of a plane at right angles to the shaft axes.

Thus, says Dean, such a freely suspended oscillating system is not subjected to any other reaction or force. The system, he feels, differs from previous devices built simply for the purpose of producing a regular vibration because the unidirectional force produced can be transmitted to a load or can act on the carrier itself. Further, it does this without reacting on or otherwise influencing the frequency or amplitude of the oscillatory movement.

Maintaining a constant angular velocity, the period of effective drive occurs at ±30 degrees about the plane of oscillation. Since this is an effective angle of 60 degrees for a pair of eccentric masses, the use of six properly phased pairs could provide an almost continuous thrust.



SIMPLIFIED SKETCH of lift-type Space Drive employing one pair of eccentric inertial masses.

• **Inventor relents**—This is a vast oversimplification of Dean's "phasing phenomena" and is the source of much confusion and misunderstanding. These processes are considered by some to be rather profound; others regard them as either contradictory or impossible.

For example, Western Gear Corporation, in performing an investigation of high-energy transmission systems under an Army Corps of Engineers contract, recently ran some studies of the Dean System.

Its physicists generally concluded after paper studies that the system couldn't work. Later, computer simulations were performed which largely substantiated Dean's claims.

In striving to protect his patent rights and prevent the stifling of future system applications by fuzzy assignments, Dean may have been his own worst enemy. So rigidly has he protected himself that he has denied industry the protection it must have before it can fund such development.

During the past month, Dean has shown a willingness to reduce some of his legalistic barriers. At least one U.S. company is now being offered a chance to study one system application.

Dean, the head of tightly controlled Dean Systems, Inc., will now go to Europe. He has informed M/R that good rapport has been established there and that initially his corporation intends to license three companies in each of several countries.

These, he says, will permit devel-

(Continued on page 47)

WET SPACEMAN ▪ The Null-Gravity Simulator—developed by Lockheed/Georgia – rotates submerged spacemen up to 80 r.p.m. to create the effects of weightlessness. This device in the Human Factors Laboratory is just one of the diverse aerospace research and manufacturing capabilities at the Georgia Division.

LOCKHEED/GEORGIA
MARIETTA, GEORGIA



ENGINEERS: GROW WITH HONEYWELL

New and expanding programs at Honeywell Aero have created these and other attractive openings now:

Airborne Digital Computer Engineer with experience in special purpose computers, transistor logic, digital input-output devices, high speed memories or miniaturized circuit methods.

Inertial Sensors Engineer with experience in classical and quantum mechanics including flotation and electrostatic techniques, cryogenic molecular spin and nuclear magnetic resonance phenomena.

Human Factors Engineer. Desire BSEE with MS in Psychology or BS in Psychology with MSEE or equivalent, to design and lay out man-machine interface specifications, control and display dynamics and perform experimental work on human control information processing abilities.

Senior Physical Chemist—Space Cabin Environment to develop methods of maintaining desired levels of gas concentration and develop processes for reclaiming waste materials for orbital, lunar, and deep space missions.

Senior Flight Systems Engineer with experience in systems design, stability and control, and configuration analysis for aircraft and/or missiles. Should be familiar with the techniques associated with satellite rendezvous, trajectory and re-entry analysis.

Senior Optical Pick-off Engineer. Experimental physicist with experience in development of small precise electro-optical devices.

Senior Systems Analyst with experience in analysis of aircraft stability and control. Familiar with both analog and digital computers and capable of applying various types of stability criteria such as phase amplitude plots, root locus, etc.

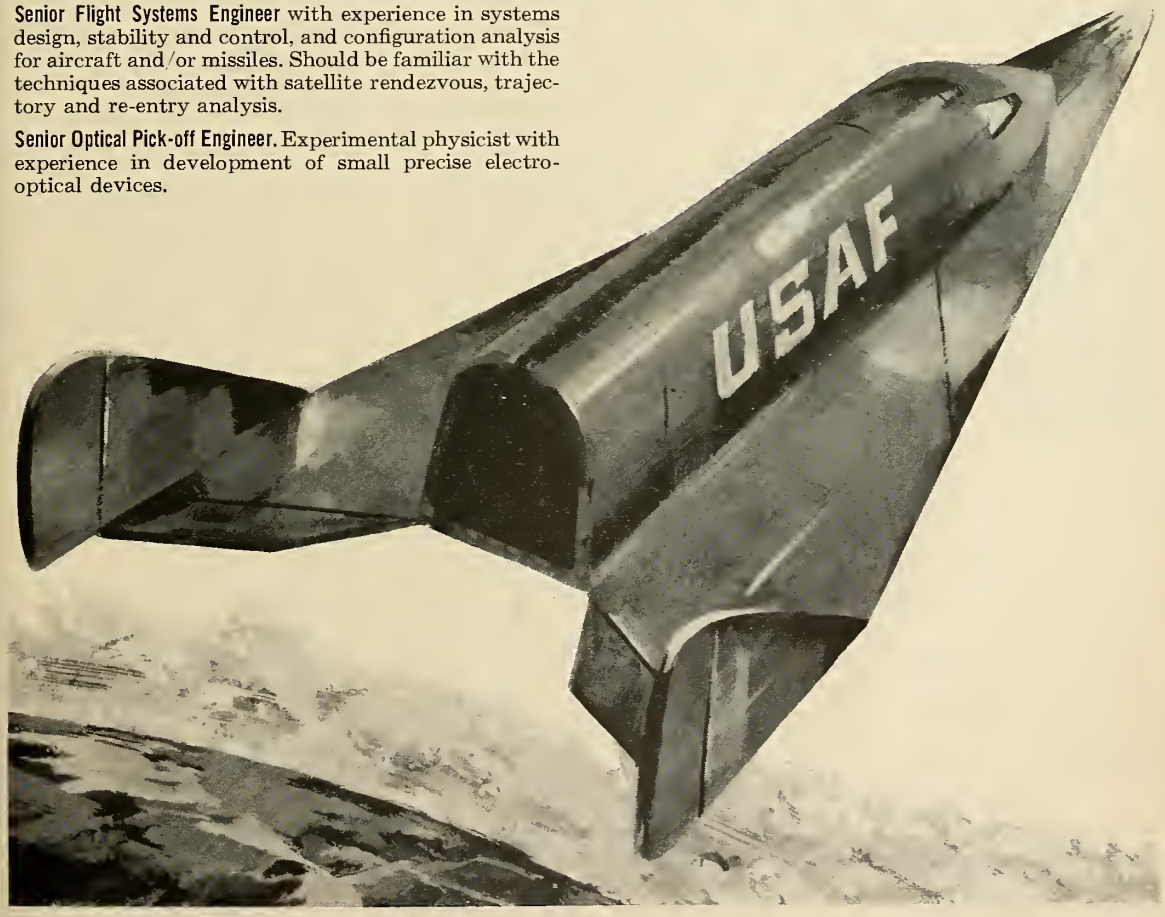
Systems Integration Specialist. Broad background in aerodynamics, thermodynamics, structures, guidance and control, configuration and design trade-offs.

Join the team selected for system responsibility on some of the most interesting—and challenging—projects now under development. Select the position best suited for you and send your resumé or request for further information to: Mr. Clyde Hansen, Technical Director, Aeronautical Division, 2624-A Ridgway Road, Minneapolis 40, Minnesota.

To explore professional opportunities in other Honeywell operations, coast to coast, send your application in confidence to: Mr. H. T. Eckstrom, Honeywell, Minneapolis 8, Minnesota.

Honeywell

H Military Products Group



Committee Wins G-D $10 Million In Contracts

An M/R report on how a top ASW contractor effectively coordinated its divisional efforts, with happy results

by William Beller



RICHARDSON



WENZEL

THREE and a half years ago, the General Dynamics Corp. formed an ASW committee to coordinate its extensive antisubmarine warfare activities.

Today, the direct result of the committee's work is $10 million in current Navy business. Moreover, the committee's indirect contributions are a continuing major influence on all of G-D's ASW programs.

The committee members, who include engineers on the decision-making level, exchange technical information, analyze the ASW market to learn where work might be needed, and pool critical scientific and engineering talent from the various divisions.

"In recent years, our business has been growing at least as fast as the Navy has been willing to spend money on ASW," says L. B. Richardson, ASW committee chairman and G-D senior vice-president-engineering. "In fact, our curve has been rising faster, which shows we are getting a somewhat bigger part of the market."

• **Beginning**—The picture has not always been this rosy. There was a time when the cost of corporate-funded studies and of proposals were greater than G-D's profits in the ASW field. The cross-over occurred about a year ago, Richardson judged.

G-D started as the Electric Boat Company, producer of all types of submarines, including antisubmarine subs. Subsequently, the corporation acquired Consolidated-Vultee Aircraft — later Convair, whose ASW strength was in making seaplanes for the Navy. Stromberg-Carlson joined G-D next, and is now the corporation's newly-formed Electronics Division. This division already has its own indoor sonar test tank —the largest privately-owned test tank in the country—and research and production contracts on acoustic equipment and sonar devices for detection work.

It is clear that G-D has been in the ASW field as long as the field has been alive. Yet, from a corporate viewpoint, ASW was not identified as a field with goals of its own and the potential for big business until early in 1957.

The real beginning of ASW as a corporate goal began when it was realized that the ASW efforts of the various divisions needed coordination, guidance, planning and—to some degree—control if the long-term best interests of the Navy and the corporation were to be served. "This was the philosophy behind the forming of the ASW Committee," said Richardson.

It soon became apparent that the problem was not going to be solved overnight, despite some predictions of a quick succession of breakthroughs. The companies attempting to build an ASW capability on the basis of such breakthroughs—there were many of them because of the wide publicity given in recent years to the ASW problem—soon saw their error. They either dropped out of the competition or realigned their energies for a long pull.

• **Taking long view**—G-D's ASW group confirmed that it was going to be a long time before ASW became big business. Meanwhile, if they wanted to stay in it, they would have to accept short shrift on profits, do some intensive advanced planning, and determine by operations-research-type analysis which were the best areas to explore.

On the brighter side, G-D feels that the amounts of money actually being programed by the Navy now for ASW work are small compared with the amounts that will be available to contractors if they come up with promising solutions to ASW problems.

"The offense that we are trying to get a defense for—the fast-growing threat of Russian subs—is increasing so rapidly that it is quite probable that we will be getting a proportionate amount of business to counter the threat," predicted J. G. Wenzel, G-D's ASW coordinator and full-time executive of the committee.

Over a period of time, G-D expects to be a major manufacturer of ASW electronic and sonar equipment, of naval ASW aircraft and other vehicles such as hydrofoil craft, and of course, of the submarines themselves.

Currently, the firm has ASW production and study contracts in every division capable of ASW work. The biggest contracts are at Electric Boat, where three Thresher class submarines —really ASW subs—are being built. This program will stretch over the next three years.

G-D Electronics is building sonobuoy receivers—a production item—and is also working on transducers and other submarine detection equipment. This division also has sizable study contracts with the office of Naval Research and the Bureau of Ships for advanced research in the detection problem.

• **Born in strike study**—The ASW Committee was set up in October, 1957. The immediate reason for its formation involved a Navy contract on which two G-D divisions—Convair/Pomona and Electric Boat—were working. This was the "strike submarine study" which was to be an analysis of a missile-launching submarine.

The present fleet ballistic missile submarine concept and the *Polaris* missile probably originated with this study.

With the strike study came G-D's first requirement to coordinate ASW efforts. In early summer of 1957, Richardson, as senior vice president, called a meeting of the top people in all the divisions who were interested in ASW, to look into the coordination problem. Out of the meeting evolved the recommendation for the present ASW Committee as an agency of the Board of Management of G-D. The committee was formed and has been operating for three-and-a-half years.

The committee includes top engineers of all the divisions with ASW work. To assure a broad picture, it also includes marketing and planning personnel. Basically, though, the committee performs engineering and planning functions.

• **Authority to act**—To keep the committee manageable, it has ten full members and eight alternates. These are the men who are actually in charge of the work at their various divisions; they have line authority.

This last point was emphasized time and time again by G-D personnel. "These fellows are the key people within each division," they said. "So when the planning and coordinating committee agrees that there is going to be a certain division of work or that a certain tack should be taken in old work or in getting new work, these people have the authority to see that the proper directions are taken. When they go home, they can put the agreements right into effect. That's the strength of this whole committee."

What this means is that very few orders have to be issued by the corporate staff. Practically everything is done by agreement. In fact, Richardson says that there has been no case yet where top management had to order somebody to do something, when an agreement was reached in a committee.

The committee deals with policy matters. It seeks to find out what ASW projects are in the offing and that G-D should go out after. It coordinates the corporation's ASW efforts to bring the strongest capabilities to bear on every proposal that is issued. In addition, each division discusses its own program, proposals it intends to submit, and plans it has for its future.

The committee also anticipates and prevents conflicts—such as two divisions bidding as primes on the same proposal. Capabilities are compared and the committee decides which shall be the prime bidder; the other divisions support the prime.

• **Examining ideas**—Between meetings, the participants report any important ASW information through the ASW coordinator, Wenzel. In turn, he

providing for the future of national defense...

RCA
advanced
military
systems
Princeton, New Jersey

Now beginning its third year, RCA's Advanced Military Systems organization is deeply involved in developing new systems concepts that will satisfy military requirements expected to arise later this decade.

These studies probe the frontiers of knowledge and encompass such areas as the physical sciences, mathematics, engineering, and military science. They have, as their end result, the creation of advanced systems concepts applicable to such military areas as SPACE, UNDERSEA WARFARE, LIMITED WARFARE and PLASMA APPLICATIONS.

Members of the technical staff are relieved of administrative detail, and devote their time primarily to purely creative work. They are able to draw heavily on the most capable talents of other departments of RCA, particularly the operating divisions of Defense Electronic Products. In addition, specialists may be called in as needed.

Their offices are in a new air-conditioned building on the spacious grounds of RCA's David Sarnoff Research Center. The community of Princeton, N. J. offers unique educational, cultural and civic advantages—and is conveniently close to New York City.

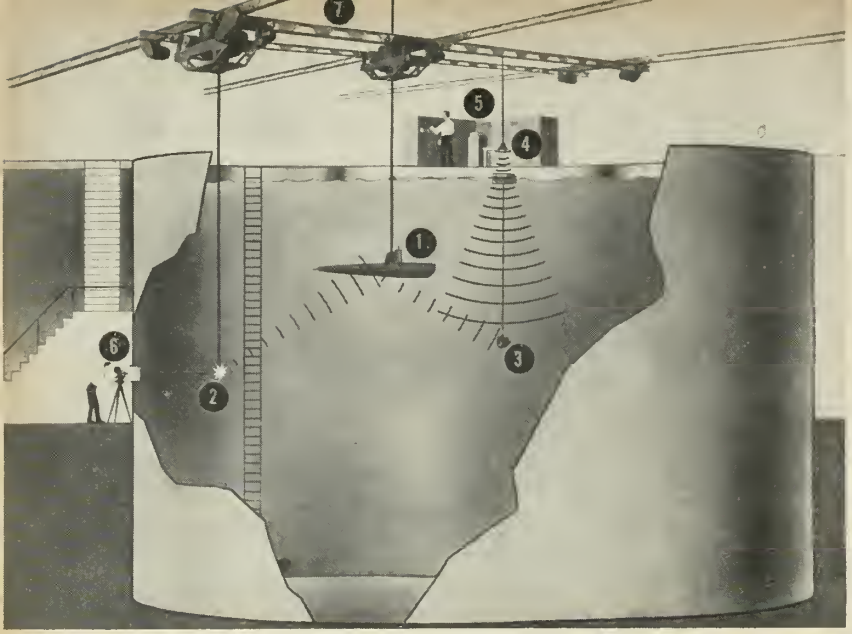
At this time, AMS is seeking a few senior theoretical scientists, engineers and mathematicians who have attained recognition in the fields of Space or Plasma Applications. If you have at least 15 years of experience and education beyond a bachelor's degree; if you are systems oriented and interested in working in an environment offering every opportunity and facility to use your creative and analytical skills to maximum advantage and at the highest level, we should like to hear from you. Write:

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LEFT: *G-D Electronics' 400,000-gal. indoor sonar test tank—largest privately owned one in U.S.—is 48 ft. in diameter, 30 ft. deep. 1) model submarine serving as "target." 2) Underwater spark providing broad-band sound source for echo-ranging. 3) Hydrophone receiving echo from submarine. 4) Loudspeaker to test sound transmission from air into water. 5) Control and instrument racks. 6) High-speed camera. 7) Overhead tramways and positioning devices.*

disseminates the information and arranges interdivision agreements, or proposes to convene a special meeting if the situation is important enough.

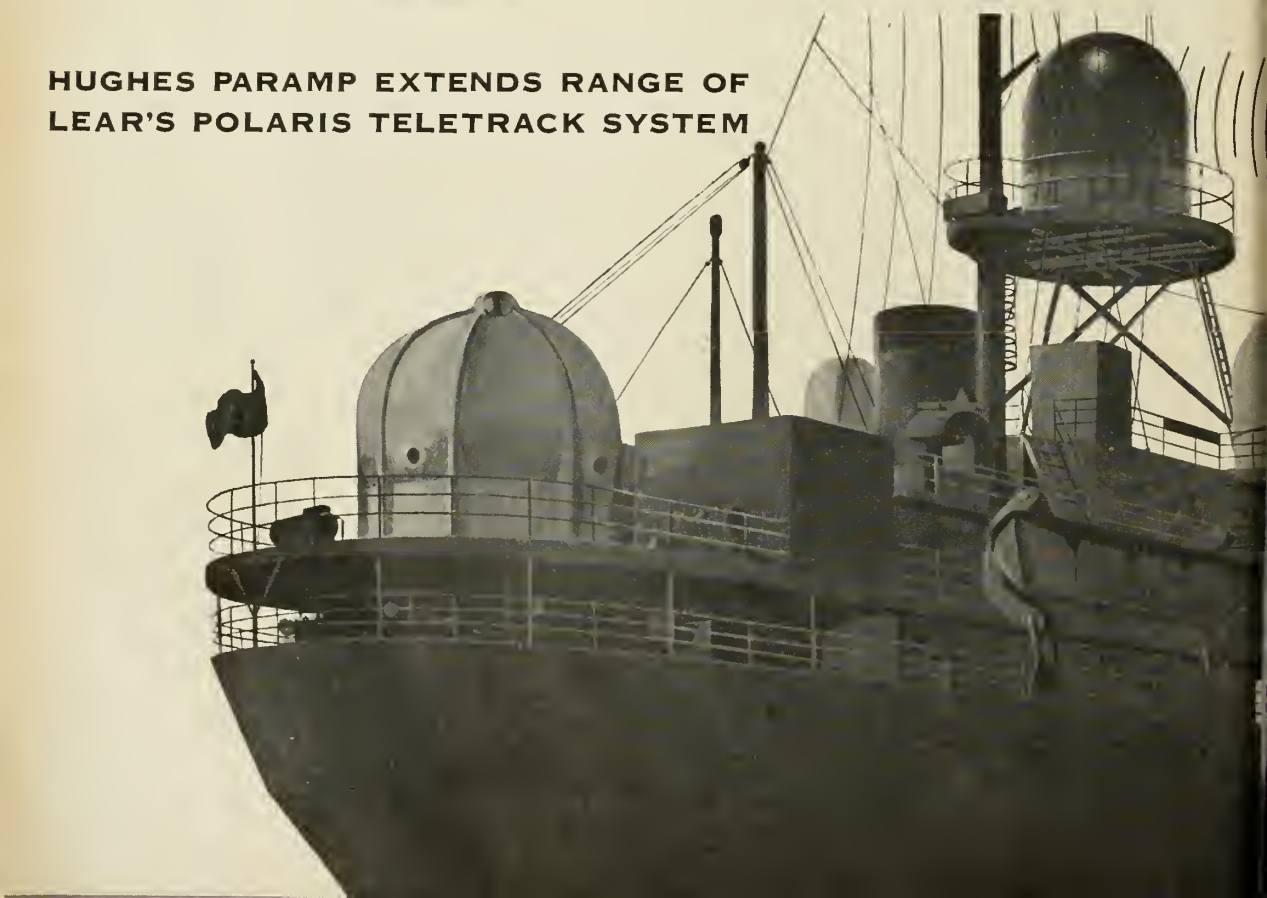
Before the ASW committee can say with reason that a given idea is a promising one or that another idea appears to be better, it must have some measuring rod. This is furnished by the Operations Analysis Subcommittee, the only standing subcommittee. Its function is to do long-range planning and guidance through operations and systems analysis.

The subcommittee, less than a year old, has tried to develop the proper and analytical tools for each job. This includes determining measures of effectiveness, ways and means of simulating analytically the capabilities of given pieces of hardware and combinations of pieces of hardware. This is an ambitious program, but one that can be immensely profitable.

The novelty is that the people are not pulled together to work at corporate headquarters. Instead, as heads of operations and systems groups in the various divisions, they stay in their normal environments so that they don't lose touch with their fields. Their efforts are coordinated under Wenzel, who is head of this subcommittee, in addition to his other duties. He calls a meeting about once every six weeks which lasts for two or four days.

At these meetings, Wenzel brings up

HUGHES PARAMP EXTENDS RANGE OF LEAR'S POLARIS TELETRACK SYSTEM



the problems proposed by the main committee and by agreement arranges for their solution. Moreover, individual OR problems, if they affect more than one division, are also discussed and acted upon. Action many times means taking the problems back down to the working levels of the divisions, solving them, bringing back the solutions or inputs for a coordinated solution. In effect, the subcommittee is the technical steering committee for the main ASW committee.

Ad hoc committees have been established from time to time. These analyze capabilities and swap ideas. For example, there was an ad hoc committee on the field of oceanography, another on the human factors aspect of ASW, and a third on the technical aspects of sonar transducer design. These ad hoc committees meet for a couple of days, exchange ideas and approaches, make their recommendations, and then disperse.

The ad hoc committees are invaluable for getting the working people of the various divisions together to be sure they know and can work with each other. In addition, the members take advantage of one another's ideas, get the ASW committee's thinking, and then return to their divisions with fresh viewpoints. ⌗

Cover Story

Test Plant Has Vast Power

AN ELABORATE million-dollar facility for testing giant high-power radar amplifier tubes is just being completed at Sperry Gyroscope's Great Neck, L.I., N.Y., plant.

Its most impressive feature is a power supply capable of delivering a peak 100 megawatts at 270,000 volts. The unit—one of the world's largest—furnishes enough power to throw a searchlight beam well beyond the moon.

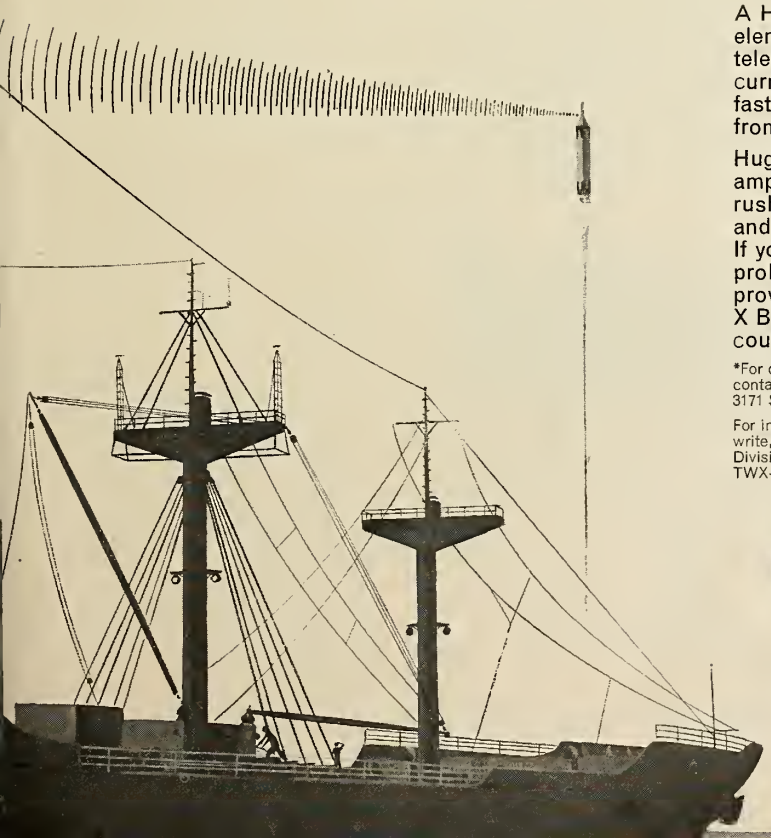
The power unit is located in a separate section—called the "non-livable area"—of the test facility. No personnel are allowed in this area, with its exposed high voltage, during operation. Interlocks and various other safety precautions are incorporated in its design to reduce hazards to almost a foolproof level. Eight-inch-thick walls, lined with metal shielding, prevent any leakage of power into the adjacent tube test area where personnel are working. The "livable area"—where actual tests are performed—contains controls and modulator components for the tests.

Before testing, tubes are assembled in an ultra-clean room. Here temperature, humidity, and dust are rigidly controlled to eliminate the possibility of even microscopic foreign materials which might affect the performance or damage the tubes. A huge crane then lifts the assembled tube and lowers it into a vacuum bake-out oven, where it is subjected to temperatures up to 1100°F for 12 hours. This helps guarantee a near-perfect vacuum in the tube.

After bake-out, the tube is placed in a high-voltage cage where controlled electrical discharges are applied to vaporize any minute irregularites on its inner surface that might cause trouble later.

For the most severe part of the test, the tube is placed in the main section of the power supply unit—a lead-lined steel tank 16 feet long and 10 feet high. Partially immersed in 3000 gallons of special oil to ensure maximum insulation, it is tested to demonstrate its power output at specific frequencies.

After tests are complete, an extensive report on each tube's performance is prepared to provide information for putting it into actual operation. ⌗

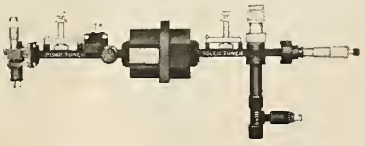


A Hughes parametric amplifier is a key element in a new *Lear Avionics Division telemetry tracking system. This system, currently under final evaluation, will enable faster and more accurate data acquisition from Polaris missiles.

Hughes delivered its first parametric amplifier to Lear 60 days ARO—received a rush order for a second unit January 16—and delivered it four days later, January 20. If you have a similar parametric amplifier problem, contact Hughes. In addition to providing "systems proven" L, S, C or X Band amplifiers, you'll get prompt, courteous and efficient service.

*For complete information regarding Lear telemetry systems contact: Manager of Marketing, Lear Astronics Division, 3171 S. Bundy Drive, Santa Monica, California.

For information regarding Hughes parametric amplifiers write, teletype or call collect: Hughes Components Division, Marketing Operations, Culver City, California. TWX-HAC SMON 7396-U. Phone UPton 0-7111, Ext. 2860.



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COMPONENTS DIVISION

Honeycomb Structure Output Speeded

Vacuum brazing process used by Grumman also cuts costs, improves properties; key is Stokes furnace

HONEYCOMB structures are being produced faster and with enhanced physical properties at Grumman Aircraft Engineering Corp, thanks to new vacuum brazing techniques.

An added benefit is a $40,000-a-month saving in consumption of argon gas.

The brazing process involves a vacuum furnace, with a 6 x 10 ft. working zone area, manufactured by F. J. Stokes Corp. The apparatus eliminates the need to completely enclose the work in an airtight metal envelope—a step that formerly took as long as two days.

J. Tunison, Grumman manufacturing engineer, says the combined cost savings will more than offset the development costs borne by his company. He adds that so far the potential of the process has only been scratched.

One special technique has been formulated for brazing stainless steel honeycomb under the Navy's *Eagle* program. The air-to-air missile was cut in the Kennedy budget, but Grumman has other projects in the brazing area. One of these involves structures of A-286, a high-temperature steel containing aluminum and titanium.

In the stainless procedure, the honeycomb sandwich is laid-up with each of the two skin surfaces separated from the core by a layer of brazing foil 0.002 in. thick. The nominal composition of this foil is 93% Ag, 7% Cu and 0.2% Li. The brazing temperature of this substance is 1640°F. To date, most of the test panels have been fabricated with this compound, but experimental work is being conducted with other brazing alloys.

The laid-up sandwich is tack-brazed together and placed in support tooling for transfer to the furnace. Graphite tooling, either flat or contoured, is used as supports. Where contours are required, tapered segments are added above the flat-base blocks for accuracy of positioning and flexibility in production.

Graphite is used in place of ceramic supports because it provides good heat conductivity and is stable at elevated temperatures, Tunison says. Some precautions must be taken because graphite has a tendency to pick up moisture and contaminate the furnace atmosphere.

Studies are being made of modifications which will utilize materials other than graphite. Contamination can be avoided by redesigning the "envelope" to exclude the graphite from the brazing area.

• **Big squeeze**—The assembled panels and tooling are placed in the furnace, with the graphite tooling on the bottom. Next to this is a 0.01-in. stainless slip sheet, then the sandwich, and above this a test sheet of the same thickness and composition as the skin of the sandwich.

Both the slip and test sheets are brushed with a compound of levigated alumina and colloidal silica. This stop-off material prevents the brazing compound from adhering to them during the process.

The next layer consists of a ⅛-in. "Fiberfax" insulation blanket and then an 0.80 stainless pressure plate. A Fiberfax wire-reinforced cloth is added and the entire workpiece gets a 0.015-in. cover plate of cold-rolled steel.

This cover plate extends over the 6 x 10 ft. work zone and bears against a water-cooled rubber O-ring which surrounds the zone.

A similar plate beneath the graphite tooling rests against another O-ring and completes the enclosure of the work zone. Graphite moisture pickup is prevented by keeping the working chamber closed and under vacuum between cycles.

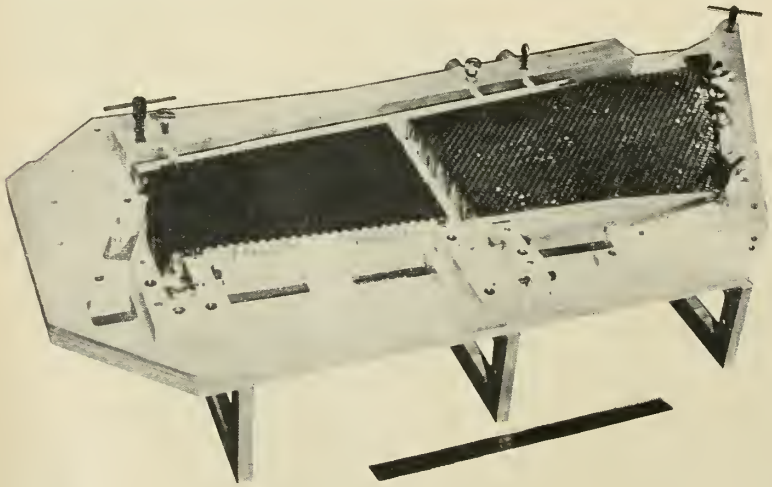
The two cover plates are firmly sealed around the work by the downward pressure of 12 hydraulic cylinders located around the perimeter. This creates the "envelope" and eliminates the need for fabricating and leak-testing a welded enclosure.

The 3-in. space between the two cover plates is evacuated to a pressure of less than 0.5 microns during the heating process. A differential pressure of 3 cm is automatically maintained outside of the work area. This provides a uniform bonding pressure against the work while heating. No mechanical pressure is applied directly to the sandwich during heating.

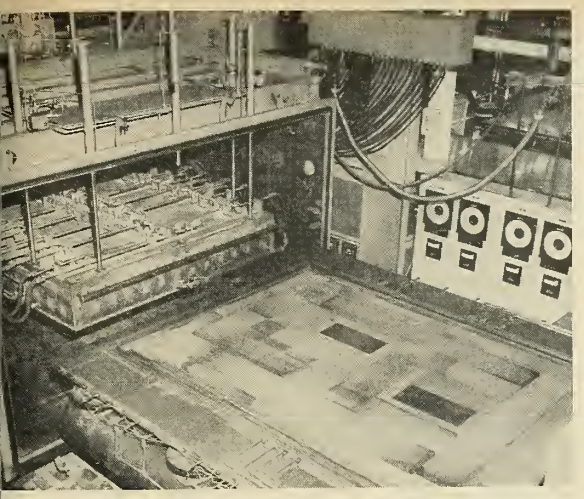
Processing conditions vary depending on the nature of the materials being brazed. If excessive outgassing is observed, the heat input in a cycle is reduced until the pressure reaches the desired level.

The cycle developed experimentally by Grumman for the *Eagle* honeycomb structures takes into account the fact that the panels have both solid bars and thin sections.

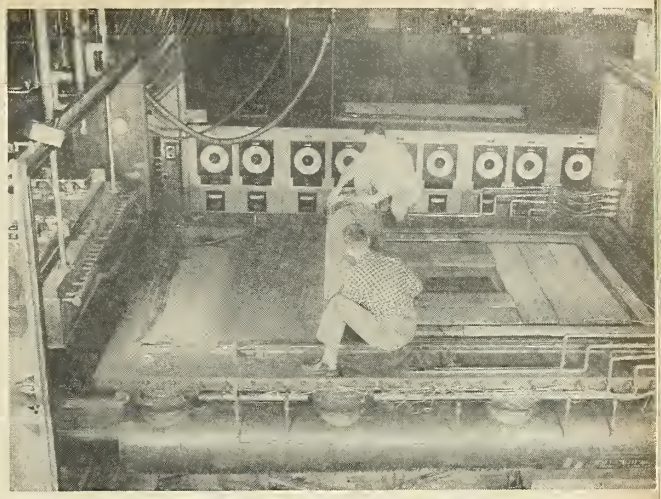
The sequence calls for bringing the workpiece temperature to a point about 100 degrees below the solidus of the brazing alloy as quickly as possible. The work is soaked at this point (1325°F) for 20 minutes to equalize the temperature and then brought to the brazing



SPECIALIZED SUPPORT tooling had to be developed by Grumman. This is a simulated aft wing layup.



TWO TEST PANELS in position on the graphite block. Surrounding space is filled with extra sections of core material to reduce the volume of the inner "envelope."



TOP COVER SHEET is unrolled over the prepared test panels. The main chamber rolls over the bed and is sealed. Upper heating elements in the chamber can be raised or lowered at will.

temperature (1640°F) for 5 minutes. Then the work is cooled swiftly to set the braze.

When the temperature has dropped to 1400°F during the cooling phase, the work zone is flooded with argon to increase the conductivity of the environment and speed the cooling cycle.

At the same time, CO_2 is let into the outer chamber to keep the pressure differential constant so that pressure is maintained on the sandwich down to the point at which the outer chamber reaches atmospheric pressure.

• **Pressure cycle**—From the moment the chamber is closed, two mechanical pumps bring the pressure down to 200 microns, where two other diffusion pumps take over and evacuate to 0.5 microns. The automatic system of maintaining the 3-cm differential was developed by Stokes; it provides for the removal of small amounts of gas from the outer chamber as the temperature rises. The total brazing cycle takes about 8 hours.

The bed of the working zone has an array of transverse radiant heating elements ranged about 6 in. apart. The movable overhead heating frame has a matching set of elements.

Both bed and upper frame have independent sets of controls which provide 10 transverse heat zones throughout the length of the furnace. The work temperature is monitored by thermocouples attached directly to the honeycomb structures and connected to a series of wires which lead through permanent outlets in the side frame of the bed. All the leads are connected to a 10-point recording thermograph which provides a continuous record of the work temperature in each of the heat zones.

• **Vacuum vs. inert**—There are several distinct advantages in vacuum brazing. The foremost is that the presence of a vacuum produces a surface cleansing action on the panel and core. This leads to an optimum bond.

Another point is that the high-temperature, high-alloy materials used in the missile/space field are extremely difficult to braze in an argon atmosphere. As these alloys are heated, the included oxides come to the surface of the metal and serve to inhibit brazing action.

In the processing cycles, however, it is said that vacuum brazing tends to be somewhat longer because of the slow

(Continued on page 47)



LFA

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Data Shows STL's Atlas-Able Engine

A detailed look at the deep-space system which performed as designed despite failure of lunar probe launching

by John W. Herrick

EL SEGUNDO, CALIF.—The first U.S.-built rocket engine designed to operate on a payload in deep space successfully passed its first test in near-space last September 25, M/R has learned.

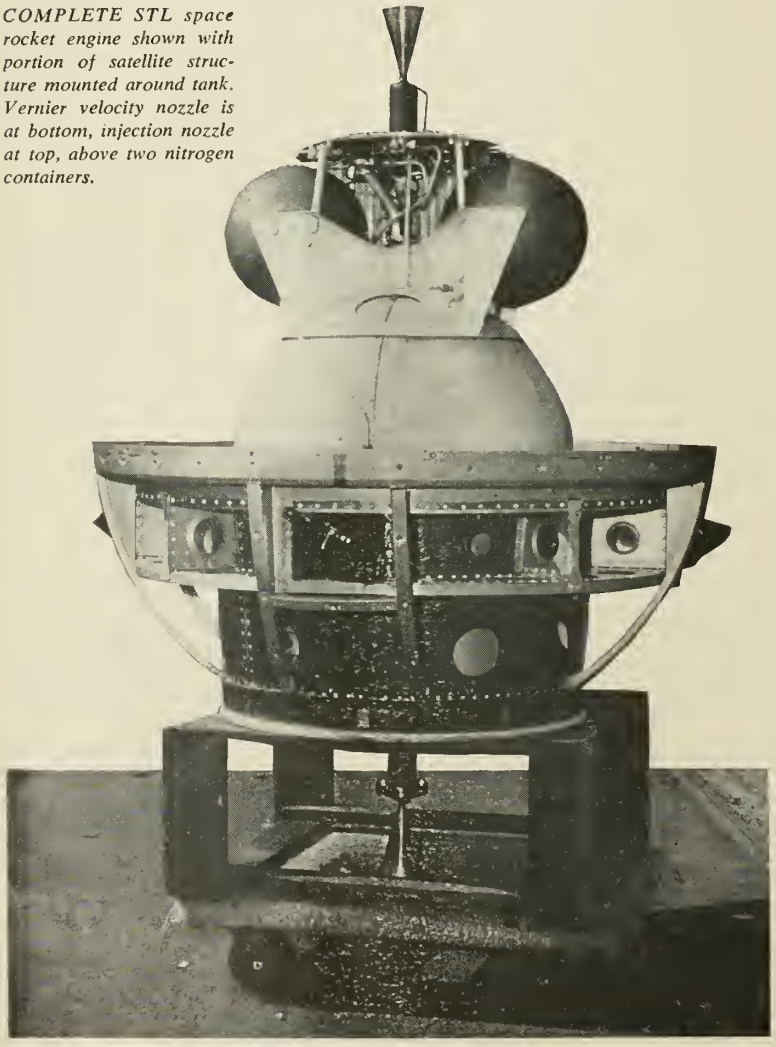
A detailed study of telemetry data from the *Atlas-Able 5A* lunar probe has disclosed that the monopropellant-hydrazine engine designed and fabricated by Space Technology Laboratories operated satisfactorily through first-phase firing—the initial vernier velocity adjustment signaled by a computer.

Unfortunately, the opportunity for 24 firings in space and deep space was never reached because each of the four attempts to launch an *Atlas-Able* vehicle failed to inject the payload, and the space engine into the correct orbit.

On Sept. 25, however, at 440-naut-mi. altitude the propellant valves on the lunar probe engine opened promptly by a command signal from the guidance computer in the second stage of the three-stage *Atlas-Able*. Data analysis showed a satisfactory ignition transient, followed by full-duration operation (142.5 sec) and a normal shutdown.

This first and only programed firing was accomplished in an unexpected manner—with at least the last stage still attached to the spacecraft. The launch was aborting at the time because of a malfunction in the second stage. Pitch angle of the remaining assemblies was extremely low, and re-entry destruction wiped out the last four attempts to orbit the moon.

The successful first-phase firing, however, indicated the propulsion system's capabilities. The remaining five firings, ground-commanded, would have been successful, according to STL's Propulsion Systems Department.



COMPLETE STL space rocket engine shown with portion of satellite structure mounted around tank. Vernier velocity nozzle is at bottom, injection nozzle at top, above two nitrogen containers.

• **New approach**—This space engine differs from all earlier propulsion systems—liquid or solid propellant—that are known to have operated at near-space altitudes or higher. The STL system is an integral part of the payload (the spacecraft), can be turned on and off as needed by command signals, and can be operated many months after launch when millions of miles from earth.

This last capability is what sets the system apart from all others such as solid-propellant spinners, cold-gas nozzles, the solid retrorocket on *Discoverer* capsules, and the restartable *AbleStar* that were earlier used successfully in space.

Space authorities recognize the STL hydrazine engine as the first of the true spacecraft propulsion systems. It is relatively simple, reliable and versatile. The basic design may be adapted to missions requiring orbital trimming, approach or re-entry deceleration, vernier velocity

functioned

adjustment, attitude-control, or any combination of these functions.

Much of the engine's simplicity begins with use of hydrazine as a monopropellant. Propellant flow is controlled by explosive-actuated single-motion valves. The propulsion system is small enough to make gas pressurization in the monopropellant tank the best choice for the feed system.

Further simplification and reliability resulted from adoption of the decaying-pressure technique. In this, sufficient nitrogen gas for the preselected number of firing phases is loaded into the ullage of the tank before launch and sealed in (locked up). The variations in thrust and impulse that result from the continual drop in pressure of the feed system during the firings are accounted for in the guidance and trajectory calculations.

One normally open and two normally closed valves replenish the pressurization gas (nitrogen) in the monopropellant tank to make it ready for a terminal injection firing. These valves are small, lightweight, and unaffected by long exposure to space environment.

Reliability is aided by use of independent feed subsystems having two explosive-actuated valves for starting and one for stopping each firing phase. The first STL design employes 12 normally closed and six normally open Conax valves to control hydrazine flow for six firings—five vernier velocity adjustments and one orbital injection at destination.

Starting of each thrust sequence in space is assured by use of hypergolic bipropellant ignition. Eight cc of nitrogen tetroxide (N_2O_4) is sprayed into the thrust chamber at the same time as the hydrazine spray enters. This mixture is spontaneously combustible (hypergolic), and enough heat is released to bring the catalyst bed (see figure) up to operating temperature.

Smooth and complete decomposition of hydrazine occurs when the catalyst is heated above 700°F. Thrust will continue to be produced until flow is stopped by energizing the normally open valve in the line.

• **A simple answer**—Coasting flight in space posed a special problem—



ONE OF TWO engine assemblies for the STL deep-space monopropellant rocket engine. Two inclined start tanks (N_2O_4) and the connector panel can be seen above the thrust chamber.

liquid propellant and pressurization gas "float" around in the tank; there is no definite interface. For a reproducible start or restart in space under conditions of zero gravity or free fall, propellant must cover the tank outlets.

Designers of the restartable *Able-Star* and the *Agena B* solved this problem by providing auxiliary low forward thrust. STL engineers chose the simple but practical answer—employ the payload spin imparted at launch for spin-stabilization. The outlet ports on their tank are located at its equator where centrifugal force directs the flow into a manifold.

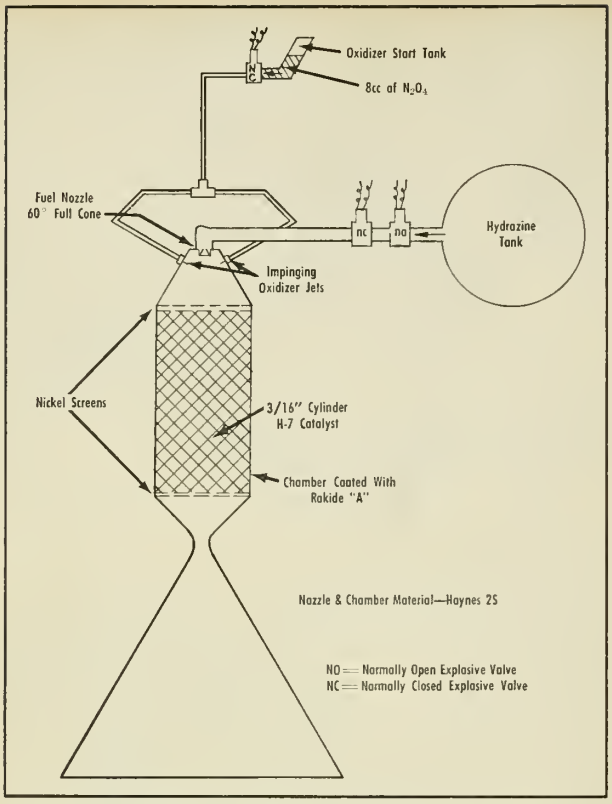
For nonspinning spacecraft, they point out, another method such as a midtank diaphragm, bladder, or tank piston could be incorporated.

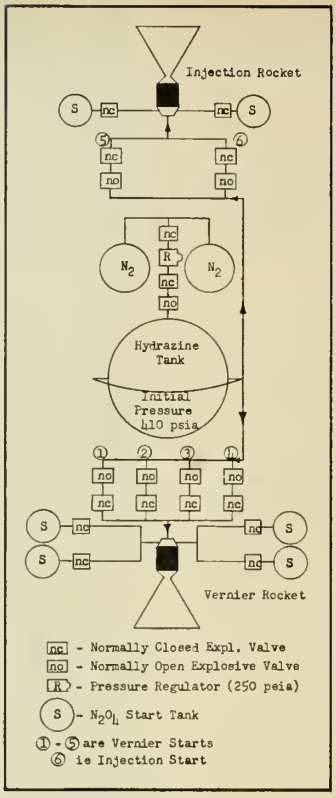
• **Built-in versatility**—One of the severe requirements in designing any rocket engine for deep space operation comes from long-duration storage of propellant and pressurization gas in the space environment—complete vacuum, extreme temperatures, and free fall. On a Venus intercept, as an example, the final velocity-adjustment firing might be delayed as much as seventy-five days after launch; the Venus injection firing could be held up an additional thirty days.

Considerations of the long coast periods led to the built-in versatility of the STL design. Each of the planned firings is completely independent and may be accomplished at any time and in any desired sequence. In short, the successful use of the complete system is not jeopardized by having just one set of valves and a single igniter. The integral metal seal in the Conax valves practically eliminates the possibility of propellant or gas leakage over periods of many months. Operational reliability of 99.99% is quoted by Conax; STL did not experience a failure in more than 400 valve firing tests.

• **First design**—The first U.S. spacecraft rocket engine was originally designed and developed by Space Technology Laboratories on a crash program to provide in-space guidance for placing a deep space probe in a solar orbit that would approach Venus. Although this task, the original *Atlas-Able 4* program, was later changed to a lunar orbiter, the design goals were not relaxed.

Two design requirements were pri-





AT LEFT: *The single thrust-chamber system for STL spacecraft rocket engine.* **AT RIGHT:** *Propellant feed system for vernier/injection spacecraft rocket system.*

mary—flexibility of firing operation and compatibility with the designated launching vehicle/payload combination. STL also aimed at minimum weight, maximum reliability, and maximum utilization of existing hardware and technology because of time limitations.

This first STL design is best identified as a velocity-vernier and orbital-injection rocket propulsion system. The name is shortened to vernier/injection rocket. Four of these propulsion systems were fabricated and delivered to NASA for the *Atlas-Able* program.

In this design the vernier and the injection nozzles were located on the spacecraft's axis, pointing in opposite directions. The spin axis was aligned with the vertical axis of the launching vehicle. Thus the vernier nozzle could make four velocity adjustments in the same forward direction as the third-stage thrust of the *Atlas-Able* vehicle. The injection nozzle might be fired for one vernier operation, in addition to its orbital injection function, in a direction opposite to the terminal trajectory.

A total impulse of 7500 lb-sec was scheduled for the *Atlas-Able* vernier operations; 27,000 lb-sec was provided for injecting the spacecraft into a lunar orbital injection function, in a direction be accomplished without additional pressurization. The thrust dropped from 25 to 16 pounds-force because of decaying pressure.

Nominal thrust rating of each nozzle was 18.5 pounds-force; measured specific impulse was 230 sec; nozzle expansion ratio, 50:1.

The long-duration injection firing upon arrival in vicinity of the moon required a regulated pressure system consisting of two 2000 psia nitrogen spheres, a pressure regulator set at 250 psia, and three Conax valves. The normally open valve shown in the diagram was included to protect the payload from an overpressurized hydrazine tank after the power plant completed the injection firing.

Burned-out weight of this powerplant was approximately 59 pounds; tankage for 178 pounds of hydrazine was provided. Eight cc of oxidizer was loaded in each of the six start tanks and pressurized by nitrogen before launch. Their outlets also were placed where centrifugal force would ensure emptying the entire content while in free fall.

• **Sequence**—A single firing of either engine is sequenced as follows:

(1) The normally closed valves in the hydrazine and the N_2O_4 feed pipes are opened by an electrical impulse from the guidance system or ground radio command, permitting the fuel and oxidizer to flow to the thrust chamber.

(2) The oxidizer is dydraulically timed to enter the thrust chamber through the impinging jets about 50 milliseconds ahead of the fuel. The mixture is spontaneously combustible, and chamber pressure rises immediately.

(3) Oxidizer flow continues for approximately 200 milliseconds, emptying the start "tank." By this time, the JPL-developed Type H-7 catalyst is sufficiently hot to maintain smooth gas generation from the hydrazine throughout the firing.

(4) The normally open valve in the hydrazine feed is closed by an electrical impulse, stopping the fuel flow and shutting down the engine.

The STL space engine system was subjected to a rugged test program that included some 620 test-firings at STL's Flight Test Facility on the outskirts of the Los Angeles airport. These runs represented a total firing duration of over 55,000 seconds. The great majority of these tests were made under vacuum start conditions using the explosive valves and actual flight-weight engines. These production thrust chambers were uncooled and made of Haynes 25 coated with Rokide "A."

Initially, certain technical difficulties were encountered, particularly with timing of the oxidizer lead during bipropellant ignition of the engine. After this problem was resolved the test program was essentially trouble-free and a high degree of confidence was obtained. The test-firings were also run under various adverse conditions, including deliberated plugging of one of the impinging jets, inadequate pressure in the start tank, and other possible malfunctions.

Excluding human errors, the last 450 of these firings were completely successful ⁂

STL to Build New Engine Test Plant, Increase Staff

EL SEGUNDO, CALIF.—Space Technology Laboratories will build a new test facility for the development and test of new space engines, as its latest move in a progressive reorganization of the former systems engineering and technical direction organization.

STL sources say one of the major efforts in this expansion into the propulsion industry will be the study, design and development of low-thrust, low-pressure rocket engines for controlling spacecraft during lunar and interplanetary missions. Their propulsion engineers claim that low-pressure systems are uniquely suited for orbital trimming, midcourse and terminal guidance corrections, attitude control, and many special space applications.

The award of contracts for the construction of two one-story structures, a test building and a control building, is expected before the end of April. The facility will be constructed on a small plot on the western boundary of Inglewood, Calif., not far from the first buildings of the Ramo Wooldridge Corporation. STL and Tapco, owners of the site, are now subsidiaries of Thompson Ramo Wooldridge Inc.

When the new propulsion facility is operating, STL expects to measurably increase its staff of rocket engineers and technicians. Previously, the Propulsion Department conducted engineering studies for the Air Force missile programs and developed a few space powerplants for NASA. Test-firings of their first space engines were made at the STL Airport Facility on the edge of Los Angeles Airport.

The concrete test building, with 1155 sq. ft. of floor space, will house two test cells, each 18 by 14 ft.; three tank bays for propellant storage, and two observation rooms on a concrete slab. The air inside the test building will be changed every seven seconds by a roof-mounted blower. This circulation system will protect test personnel from stray vapors in case toxic propellants are used. In addition a drainage system beneath the tank bays and test cells will keep the test area in a safe and sanitary condition. Doors of one-in. steel plate will isolate the tank bay area.

The four horizontal test stands in the open-end test cells will direct the rocket exhaust streams against a large earthen bank to suppress the sound.

The second building, with 1710 sq. ft. of floor space, will house the control center with special test control consoles in an air-conditioned room, a machine shop for fabrication of test hardware, and an equipment room. This control building will be of standard wood-frame and stucco construction.

The other buildings on the Tapco site were originally erected to conduct fuel system tests on the full-size Air Force *Navaho* missile. ⌗

Protons Threaten Solar Cells and Transistors

HIGH ENERGY protons in the Van Allen belts and solar clouds present a major problem in the design of electronic circuits containing semiconductor devices and solar cells, a technical report of the National Aeronautics and Space Administration said last week.

Protons in the 22 and 240 mev energy bands definitely damage transistors and solar cells, according to a technical note (D-718) by W. C. Hulten, W. C. Honaker and John L. Patterson of NASA's Langley Research Center. They said there were no apparent effects on the types of resistors and condensers tested.

Tests were conducted with the use of the 22 mev proton accelerator at the Oak Ridge National Laboratory and the 240 mev proton accelerator at the University of Rochester.

Transistors irradiated in the 22 mev cyclotron showed extreme in-beam transient effects, probably caused by the ionization within the transistors. Ionization was directly proportional to flux.

Data collected from the 240-mev experiment indicated that higher frequency transistors are less sensitive to radiation at that level. Comparison of the two sets of results indicates that low-energy particles cause greater permanent damage to transistors. ⌗

Dean Space Drive

(Continued from page 34)

opment for specific applications which are non-conflicting in function. The aim of the group is and apparently will continue to be to deal only with companies wholly owned within each particular country.

• **Scoffers**—To Dean's contemporaries, the concept of the non-simultaneity of the action-reaction processes and its application to the rectification of centrifugal force is a radical one. But there appears to be some realization that the fact that his concept is not fully understood is not of itself sufficient reason to disbelieve it.

Historically, there are those who scoff at almost every new technological conquest, in every century. This nation has been plagued over and over again by costly mistakes committed by those unwilling to accept change; too often it has been the "expert" who has led the opposition.

The Christie Tank Suspension System is typical. Invented long before World War II, it was offered to the U.S. Army time and time again by the inventor. Finally, in desperation, it was offered to several foreign governments. The result during the early 1930's was the development of vastly superior armored vehicles in both Russia and Germany. By World War II the lead was commanding—and we required years and lives to catch up.

The Dean System, its proponents argue, is not in the same far-out category as anti-gravity or perpetual motion machines. Yet, while demonstration devices appear to show proof of principle, a practical machine has not been made that can perform useful work.

If computer simulations continue to support Dean's belief, Space Drive supporters feel there is a strong case for nurturing the concept, developing it and putting it to work.

For the present, it's in a state of limbo. ⌗

Vacuum Brazing

(Continued from page 43)

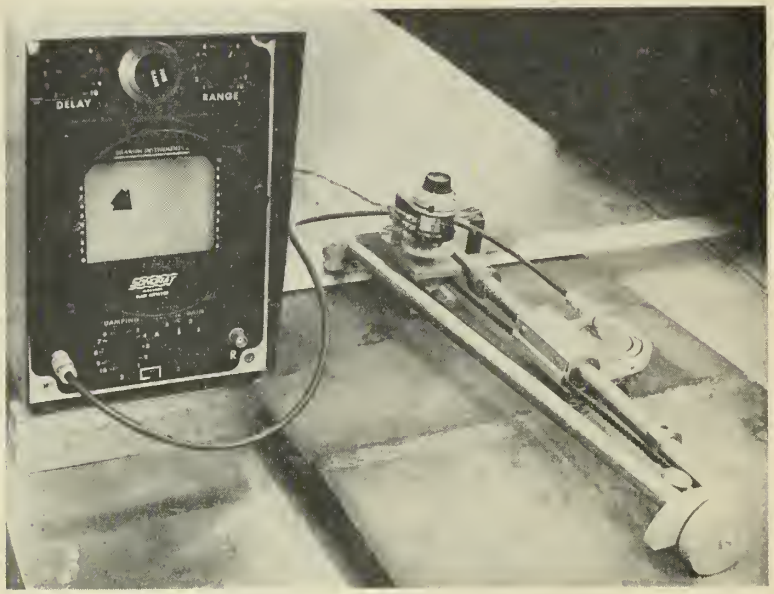
cooling rate. The longer heating period does affect the physical properties of the material itself.

Normally, in inert gas brazing, the type of stainless used by Grumman would be cooled after brazing to 1400°F in 20 minutes, and held at this point for 90 minutes. It would then be cooled to 60° in 5 minutes and held for 60 minutes. This would be followed by a return to 1050°F for 90 minutes.

To overcome the slower cooling rates of vacuum brazing operations, Grumman developed its own cycles for the Stokes furnace. These cycles produce physical properties in the finished structures comparable to those obtained through normal heat-treating methods.

The procedure calls for cooling the work from 1640° down to 1000° in 55 minutes, then bringing the work down to 400° in a 2-3 hour period. The sandwich is immediately refrigerated at —100° for 3 hours. Reheating to 950° for 90 minutes follows before it is allowed to cool to room temperature.

This heat cycle was developed for 15-7 Mo. Grumman has obtained panels with up to 250,000 psi ultimate tensile strength, 220,000 psi yield and 3-6% elongation. Varying cycles would be required for other high-alloy materials. ⌗



B-Scan Weld Inspection

Branson Instruments, Inc. is marketing an ultrasonic "B-Scan" weld inspection instrument. The device operates at higher speeds than those of X-ray inspection, has lower original and operational costs and faster and often more reliable results, and poses no radiation danger to quality control personnel.

The B-scan actually draws a picture of the crack or slag inclusion on the Sonoray's cathode ray tube; the location and extent of the fault can be precisely and quickly determined. Tedious calculations are eliminated, and operator training needed for reliable interpretation takes about a week.

Circle No. 225 on Subscriber Service Card

Space Environment Facilities

F. J. Stokes Corp. has developed a complete range of systems for simulating very high altitudes, extremely low temperatures, and other unusual characteristics of space environments.

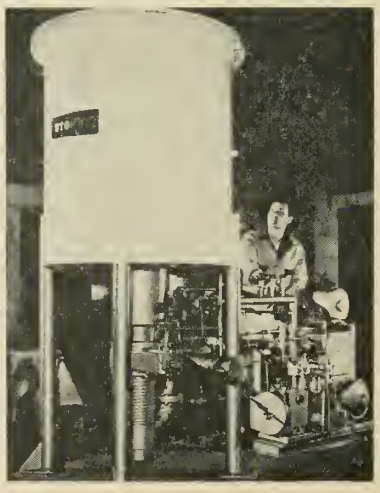
The equipment includes systems for testing the reliability under these extreme service conditions of complete space vehicles, major system subassemblies and components, and individual elements.

The smallest of these systems is the Model 290 Test Facility, for testing individual elements such as resistors, transistors, or capacitors, and small subassemblies.

The next larger size system, for testing major equipment items of space-borne vehicles has the very high-speed pumping capacity necessary to maintain the extremely low-pressure environment required when insulating material, phenolic plastics, and other materials are involved which have heavy out-gassing characteristics under heating.

Entire satellite or space-probe must also be tested under conditions simulating outer space. For this operation, Stokes is prepared to design, furnish, and install special facilities erected in the field for the hyper-environmental testing of complete space craft.

Circle No. 226 on Subscriber Service Card



USA2N697 Transistor

The USA2N697 silicon mesa transistor is available from the Semiconductor Division of Hoffman Electronics Corp.

The unit fulfills all requirements specified by MIL-S-19500/99A(SigC). The 2N697 transistors meet storage temperature requirements of 300°C and operating life tests at full power dissipation for 1000 hours. The 2N697 is rated at two watts power dissipation.

Circle No. 227 on Subscriber Service Card

Miniature Tunnel Diode

Sylvania Electronic Products Inc. has developed a miniaturized tunnel diode, which oscillates at frequencies of 10,000 megacycles and above.

Designated D-4168-D, the 10 kmc, P-type germanium tunnel diode has peak currents of approximately 3.5 ma and minimum peaks to valley ratios of 5:1. Peak current ranges from 4 to 50 ma have also been developed.

The P-type unit appears to have ultimate frequency capability of at least 12 kmc and can be made with higher current to capacity (I/C) ratios.

Circle No. 228 on Subscriber Service Card

Computer Strain Gage

A bonded resistance-foil strain gage —with a built-in computer that solves general strain-to-stress equations automatically—has been developed by Electronics & Instrumentation Div. of Baldwin-Lima-Hamilton Corp.

The SR-4 stress-strain gage provides electrical responses which are proportional to either stress or strain, at the discretion of the user, by using two independent axial strain-sensing elements oriented 90° apart.

One element measures the conventional strain. The other element acts as the automatic computer by rejecting the axial component of strain caused by stress in a transverse direction. The combined elements then respond only to that component of strain which is produced by stress in the axial direction.

Circle No. 229 on Subscriber Service Card

Temperature Transducer

Winsco Instruments & Controls Co., is marketing ultra-miniature resistance temperature transducers. The small element diameter provides minimum interruption of fluid flow and can be readily placed in difficult-to-reach measuring points.

The element diameter is 0.100 in. with time response down to 20 milli-

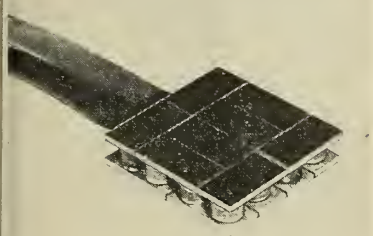
seconds or less with tungsten elements. The sensitive length of the element is 0.35 in. The calibration of the transducer will be repeatable within ±0.05% of its resistance value measured at 77°F. The transducer will meet or exceed the vibration and shock specifications of MIL E 5272C.

Circle No. 230 on Subscriber Service Card

Thermoelectric Junctions

Troublesome overheating of "black box" circuits caused by heat dissipation of power transistors and other components can now be corrected by various spot cooling applications of new thermoelectric components available from the stock of Ohio Semiconductors, a division of Tecumseh Products Co.

Ohio Semiconductors is marketing the TA-20, a "Thermo-Array" of several smaller TA-12 junctions. The TA-20 is also produced as a finished "Thermo-Module," the TA-20M, with 1/16-in.-thick aluminum plates on top and bottom, ready for use as a complete TE unit.



The unit can handle jobs calling for careful temperature control and large heat pumping capacities. The single module is small and of rigid construction. It can pump more than 20 watts, or typically attain a temperature differential ($\angle T$) between hot and cold plates, in excess of 80°C.

Circle No. 231 on Subscriber Service Card

Compact Linac

A linear accelerator is available from Tayco Developments, Inc.

It consists of the linac console, and control panel for accelerating up to 105 mph in 7 in., maintaining it for a distance of 24 in. and decelerating to 0 in 8.5 in. During operation, the unit develops from 240 to 1000 g's as a controlled function and 760 horsepower on a 1½-in. O.D. shaft.

Circle No. 232 on Subscriber Service Card

Airborne PCM System

A PCM system with exceptional flexibility for telemetering digital data during flight tests of high-performance aircraft and missiles is available from Electro-Mechanical Research, Inc.

The system multiplexes and digitizes with 8-bit accuracy, low-level transducer signals in the range of 0 to 20 mv. Signals can be floating, single-ended, or balanced. Common-mode rejection is excellent. Common-mode signals of ten times full-scale amplitude in the frequency range of dc to 3 kc cause no more than 0.1% full scale change in the output. Programed, solid-state switches with outstanding characteristics provide input signal multiplexing. Sampling rates per channel as high as 10 kc can be programed.

Circle No. 233 on Subscriber Service Card

Servo Analyzer

The Electronics Division of Chance Vought Corp. has developed an all-electronic servo analyzer which measures phase and gain response on servo systems, amplifiers and other equipment with greatly increased effectiveness. Features include a wide frequency range for both modulation and carrier frequencies, electronic modulation and inherent stability in both amplitude and frequency far exceeding that of similar instruments in the field. The servo analyzer provides modulation rates of 0.005 to 1000 cps, covering the dynamic range of most servo systems but without the maintenance requirements of mechanical multipliers. These rates are provided in sinusoidal, step and ramp functions either directly or in suppressed carrier form.

Circle No. 234 on Subscriber Service Card

FM-FM Telemetering System

The Solid State Electronics Co. is marketing an ultraminiature Model 5000 silicon transistorized FM-FM telemetering system.

The system has been designed for the purpose of obtaining data from systems in a state of high acceleration, such as rotating machinery, from which measurements such as temperature, strain, pressure, acceleration, force and motion are ordinarily difficult to obtain. The transmission of data is by means of a radio frequency link between the Model 5000 system and a remote receiving station.

The Model 5000 system is basically comprised of a transducer, subcarrier, oscillator, RF transmitter, and an appropriate antenna. Various stimuli are sensed by a calibrated transducer which modulates the frequency of the subcarrier oscillator. The oscillator then modulates the radio frequency of the transmitter. The measured data, in the form of FM-FM signals, are then sensed by the remote FM receiver which discriminates the subcarrier frequency.

The output of the receiver can be fed to a counter, recorder or printer. The calibrated frequency count will be proportional to the original stimulus, thereby providing the desired data.

Circle No. 235 on Subscriber Service Card

new literature

SYNCHROS—A quick-reference catalog compiling some 200 resolvers and synchros by the Instrument Division of American Electronics, Inc. has been issued for the convenience and aid of systems and computer design engineers. The catalog offers fundamental engineering data in easy-to-read form. Ten basic parameters are covered for each unit. A quick reference to the input voltage, impedance and transformation ratio values will assist the design engineer in the application of these high-precision servo components. Typical views of the units, dimensional drawings and circuit diagrams aid in proper selection.

Circle No. 200 on Subscriber Service Card

ANALOG COMPUTING—A complete operator's handbook on analog computing is available from Electronic Associates, Inc. Written as an operator's manual for EAI's PACE TR-10 transistorized analog computer, the book provides a comprehensive introduction to the capabilities and operation of general-purpose analog computers. The advantages and relative simplicity of analog computers over digital computers in solving many engineering problems are clearly described.

Circle No. 201 on Subscriber Service Card

STRESS RUPTURE DATA—New data illustrating the excellent high-temperature stress rupture properties of air-melted cobalt base WI-52 superalloy as compared to the more expensive vacuum-melted nickel-base superalloys is available from WaiMet Alloys Co. Comparative curves, developed by Bristol Siddeley Engines, Ltd., show that nickel-base, vacuum-melted alloys have only very slightly higher stress rupture properties in the 1800° to 2000°F temperature range than the cobalt-base, air-melted WI-52 superalloy.

Circle No. 202 on Subscriber Service Card

DESIGN DATA—A data sheet describing the design advantages of Polyform has just been released by Barber-Colman Company. Polyform is a method of forming metal enclosures in one piece. These enclosures can be shaped in any configuration, giving designers a new design freedom. This data sheet includes information on: shapes, materials, strength, electromagnetic shielding, size, tolerances, and machining characteristics.

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Stephen J. Jatras: Promoted to vice president of Lockheed Electronics Co. and general manager of the Avionics and Industrial Products Division, Los Angeles.

Charles S. Payson: Elected chairman of the board of directors of Vitro Corp. of America, New York City. Associated with the Vitro companies since 1949, Payson helped organize Vitro Corp. of America and has been a member of the board of directors since its formation.

Charles R. Able: Vice president-defense programs, and **Jackson R. McGowen,** vice president-commercial programs, elected to the board of directors, Douglas Aircraft Co., Santa Monica, Calif.

Robert L. McGrath: Former director of production control, promoted to manager of production control in General Dynamics/Electronics' Military Products Division, Rochester, N.Y.

Dr. Joseph C. Wijman and **Elmer E. Weismantel:** Named supervisors of physical metallurgy alloy development and mechanical metallurgy, respectively, of The Beryllium Corp., Reading, Pa.

Laszlo J. Bonis: Former technical director, appointed executive vice president of Ilikon Corp., Natick, Mass.

William J. Whitehouse: Appointed director of manufacturing of Pesco Products Division, Borg-Warner Corp., Bedford, Ohio. Whitehouse was formerly production manager.

John S. Luce: Named special assistant in Aerojet-General's Nucleonics Research and Development Division, San Ramon, Calif. Prior to joining Aerojet-General, Luce was head of the Exploratory Physics Group, Thermonuclear Experimental Division at Oak Ridge National Laboratory.

Capt. Ashton Graybiel, MC, USN: Director of research at the U.S. Naval School of Aviation Medicine, presented the Eric J. Liljencrantz Award by the Aerospace Medical Association for his studies on the physiological effects of space flight.

M. D. Margolis and **T. H. McNary:** Named program managers for the *Minuteman* System Management of Autonetics Division of North American Aviation, Inc., Downey, Calif.

J. Carl Moore: Appointed director of manufacturing, and **John P. Leahan** manager of industrial planning, for the Aerospace-Rockets Division of Bell Aerosystems Co., Buffalo, N.Y.

Richard Blythe and **David Wilson:** Named project manager and chief designer, respectively, for cyrogenic product development of Hydro-Aire Co., Burbank, Calif.

Robert E. Lewis: Former president of Sylvania Electric Products, Inc., elected president and chief executive officer and a director of the Perkin-Elmer Corp., Norwalk, Conn.

Kenneth M. Miller: Former vice president of Motorola Aviation Electronics, named vice president and general manager of Daystrom-Pacific, Los Angeles, a division of Daystrom, Inc.

Ralph H. Ruud: Elected vice president of North American Aviation, Inc. and president of the Los Angeles Division. Ruud has been with North American since 1931.

Edwin S. McCollister: Named director of marketing for the Univac Division of Sperry Rand Corp., N.Y. Previously McCollister was assistant vice president of the Burroughs Corp. and general manager of the Data Processing Systems Group.

Dr. Leonard S. Sheingold: Director of the Applied Research Laboratory, Sylvania Electric Products, Inc., named Chief Scientist of the Air Force. Dr. Sheingold succeeds **Dr. Alexander H. Flax,** who returns to his former position as vice president and technical advisor of Cornell Aeronautical Laboratory, Syracuse, N.Y.

Ralph S. LaMontagne: Appointed marketing manager of Waltham Laboratories of Sylvania Electric Products, Inc. **Robert R. Goldsborough, Jr.,** named manager of engineering operations department at Sylvania's Systems Laboratory, Mountain, View, Calif.

Dr. John F. G. Hicks: Named associate director of Battelle Memorial Institute, Columbus, Ohio. Dr. Hicks was formerly vice president of Corning Glass Works and vice president and technical director of Corning Glass International.

William B. Lurie: Former senior project engineer and program director of General Precision Laboratories, Inc., joins Burnell & Co., Inc., Pelham, N.Y., as chief engineer.

Harold R. Walton: Appointed manager of the product information department, Instrument Division of Lear, Inc.

Guy H. Hearon and **Walter E. Brown:** Promoted to vice president of Photo Instruments Division and Field Services Engineering, respectively, of Benson-Lehner Corp., Santa Monica, Calif.

Robert S. Putnam: Joins Pacific Semiconductors, Inc., Lawndale, Calif., as manager of industrial relations. Putnam succeeds **Joseph C. Ross,** named division manager, Micro-Electronics.

Caleb Warner: Named general manager of Magnion, Inc., Cambridge, Mass. Warner formerly was with Arthur D. Little, Inc.

Alfred W. Flint: Appointed chief project engineer for the Engineering Services Division of Integron, Inc., Waltham, Mass.

Clifford W. Snider: Appointed secretary/treasurer of Space Electronics Corp., Glendale, Calif. Previously Snider was with Solar Aircraft Co., San Diego.

Allen S. Clarke: Elected chairman, and **Semes D. Walsh,** a director, of the Board of Directors of Communication Electronics, Inc., Bethesda, Md.

Thomas W. Cushing: Promoted to manager of the military service department of Engelhard Industries, Inc., Newark, N.J.

Edward P. Tagge: General auditor for Beckman Instruments, Inc., Fullerton, Calif., named assistant to the president.

contracts

NASA

$227,000—**Marshal Laboratories**, San Marino, Calif., from Jet Propulsion Laboratory of Calif. Institute of Technology, for development and production of magnetometers to measure magnetic fields in outer space aboard missile and space vehicles.

MISCELLANEOUS

$2,400,000—**Epsco, Inc.**, Cambridge, Mass., from **The Martin Co.**, for missile-borne data recovery systems and ground receiving stations; $200,000 from **The Martin Co.** for three PCM/Video and Signal Conditioner Checkout Systems for pre-launch testing of missile-borne packages.

Chance Vought Range Systems Division, from Pacific Missile Range, for technical support services on Kwajalein Atoll when *Nike-Zeus* is tested against an *Atlas* launched from Vandenberg AFB. No amount disclosed.

NAVY

$76,200,000—**Electric Boat Division of General Dynamics Corp.**, Groton, Conn., for construction of two *Polaris* missile-firing submarines.

$75,314,000—**Newport News Shipbuilding & Drydock Co.**, Va., for construction of two *Polaris* missile-firing submarines.

$36,325,842—**General Electric Co.**, Syracuse, N.Y., for AN/SPS-30 height-finding radar and antenna and initial instructional and training services.

$26,639,000—**General Electric Co.**, Schenectady, N.Y., for procurement of nuclear components of *Polaris* submarines.

$4,000,000—**Control Data Corp.**, Minneapolis, from **General Electric Co.**, for eight digital geoballistic computers for the *Polaris* submarine Mark 84 fire control system.

$2,038,295—**General Time Corp.**, La Salle, Ill.; for quantity production of fuzing devices for the *Zuni* rocket.

$363,689—**Tracerlab, Inc.**, Richmond, Calif., for IM-151/WDQ radiacmeters, equipment repair parts, engineering services and transportation. (Two contracts.)

$217,876—**Mink-Dayton, Inc.**, Dayton, Ohio, for disposable shipping containers for guided missiles with disposable metal pallets.

$216,025—**RCA Defense Electronics Products, Moorestown Missile and Surface Radar Division**, N.J., for TS-573(C)UP radar range calibrator.

ARMY

$2,479,500—**Sperry Rand's Sperry Utah Division**, Salt Lake City, for continued development of the *Sergeant* ballistic missile system.

$2,408,658—**White Diesel Engine Division of White Motor Co.**, Springfield, Ohio, for diesel engine generators with switchgear for *Titan II* missile launch facilities.

$940,000—**J. W. Fecker, Inc.**, Pittsburgh, for 13 Contraves high-speed photographing systems for use at White Sands Missile Range, N.M.

$487,811—**The Martin Co.**, Orlando, Fla., for procurement of repair parts and modification kits for *Lacrosse* missile system together with engineering orders issued to correct system deficiencies. (Three contracts.)

$471,122—**Raytheon Co.**, Waltham, Mass., for concurrent repair parts for the *Hawk* missile system. (Two contracts.)

$437,390—**The G. C. Dewey Corp.**, New York City, for services and materials for Phase III of the *Sage* missile master integration tests.

$308,100—**Kaysam Corp.**, Paterson, N.J., for meteorological balloon.

$290,173—**Utility Fan Division of Utility Appliance Corp.**, Los Angeles, for fans, Groups I and II, for *Titan II* missile-launch facilities.

$278,680—**Hart & Hyding, Inc.**, San Francisco, for construction of *Nike-Hercules* improved with hipar site.

$221,000—**Erbentraut & Summers**, San Francisco, for *Nike-Hercules* improved with hipar.

$214,300—**General Precision, Inc., Link Division**, Binghamton, N.Y., for design and development of a prototype ballistic camera synchronization and control system in accord with White Sands Missile Range Technical Exhibit requirements.

$110,812—**Cubic Corp.**, San Diego, for electronic trajectory measuring system.

AIR FORCE

$9,500,000—**Kollsman Instrument Corp.**, New York City, for automatic astro compasses.

$6,000,000—**Convair and Space Technology Laboratories**, for investigation of the *Bambi* concept of ballistic missile defense. (Two contracts.)

$3,400,000—**Ryan Aeronautical Co.**, San Diego, for *Q-2C Firebees*.

$268,205—**Geo Sciences Division, Texas Instruments, Inc.**, Dallas, for development of an automatic marine seismic monitoring and recording device.

$214,446—**Boeing Airplane Co., Aero-Space Division**, Seattle, for modification of WSE, *Bomarc* weapon system.

$100,000—**Marquardt Corp.**, Van Nuys, Calif., for design and fabrication of fuel injectors for use in Project *Joshua*.

$100,000—**Instrument Division of Laboratory for Electronics, Inc.**, Boston, for production of 5024 microwave stability tester for use with the *Sage* radar system.



reviews

INERTIAL GUIDANCE, Charles S. Draper, Walter Wrigley and John Hovorko. Pergamon Press, New York, 130 pp., $6.50.

Probably the most useful compact volume on the subject, this tightly-written but complete book covers elemental considerations through the latest applications in missiles and other vehicles. It is aimed at the graduate-level engineer and treats both the physical principles and engineering approaches involved in inertial guidance systems.

The authors believe that the ultimate system is a feed back operating in three-dimensional space in the gravitational field as its sole environment. No system categories are established, however, and the main theme is the description of similiarities and differences of various engineering approaches.

After briefly covering the history of inertial guidance, the work ascends a moderately steep curve into the more technical aspects of its subject. The authors use drawings to great advantage, and mathematics is applied where needed.

The book meets the standard one would expect, considering its authors' backgrounds.

TRAJECTORY CONTROL IN RENDEZVOUS PROBLEMS USING PROPORTIONAL NAVIGATION.

Luigi S. Cicoloni. Order NASA Technicol Note D-772 from Notionol Aeronoutics ond Spoce Administrotion, Woshington 25, D.C. 44 pp.

The rendezvous problem is defined by the end conditions that the position and velocity of a vehicle and its target are to be matched. In its present form, proportional navigation theory allows the interception of a target by the vehicle—that is, the matching of positions.

This report extends the theory to include the full rendezvous end conditions. Trajectory constraint equations are derived and the method of computing the required thrust program in idealized problems is outlined. An acceleration-forcing function is also derived and its properties examined.

A PRELIMINARY INVESTIGATION OF THE EFFECT OF BUMPERS AS A MEANS OF REDUCING PROJECTILE PENETRATION. John O. Funkhouser.

Order NASA Technicol Note D-802 from Notionol Aeronoutics ond Spoce Administrotion, Woshington 25, D.C. 17 pp.

Aluminum bumpers and main targets were impacted with 0.062-in.-diameter copper projectiles. The reduction in total penetration was caused primarily by the breakup of the projectile after impacting a 0.031-in.-thick bumper spaced one inch in front of the main target at a velocity between 8000 and 9000 fps.

With an average projectile velocity of 11,500 fps, a bumper thickness between 0.01 in. and 0.02 in. gave the best protection against penertation. An increase in the spacing of a 0.031-in.-thick bumper in front of the main surface beyond a distance of 2 in. had very little effect on the total penetration.

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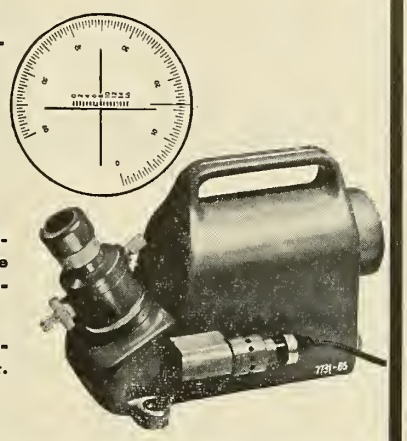
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Electric Components Conference, Institute of Radio Engineers, Electronic Industries Association, Western Electronic Manufacturers Association, American Institute of Electrical Engineers, Jack Tar Hotel, San Francisco, May 2-4.

ARS/ORNL Nuclear Applications in Space Conference, Oak Ridge National Lab, Gatlinburg, Tenn., May 3-5.

National Aeronautical Electronics Conference, IRE, Miami and Biltmore Hotels, Dayton, May 8-10.

Fifteenth Annual Power Sources Conference, sponsored by U.S. Army Signal Research and Development Laboratory, Shelbourne Hotel, Atlantic City, N.J., May 9-11.

Western Joint Computer Conference, American Institute of Electrical Engineers, Institute of Radio Engineers, and Association for Computing Machinery, Ambassador Hotel, Los Angeles, May 9-11.

Society for Experimental Stress Analysis, Benjamin Franklin Hotel, Philadelphia, May 10-12.

National Armed Forces Day Dinner, sponsored by Navy League, The Military Order of the World Wars, and the Air Force Association, Sheraton Park Hotel, Washington, D.C., May 12.

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editorial . . .

The People Wait to be Told

NOW THAT THE WAY has been cleared for Vice President Johnson to head up the Space Council, the Administration should move quickly to provide the nation with the vigorous, imaginative leadership it requires in the space field.

During the presidential campaign, President Kennedy first outlined his views on missile/space problems in this magazine. He laid out an alert program which we applauded at the time.

Since taking office, however, his actions have left something to be desired. His critics have been quick to spot a "me-tooism" in his approach to space which resembles the do-nothing days of the Eisenhower Administration.

This is not entirely justified. The New Frontiersmen have made a number of laudable steps in the right direction. Solid recognition of a military role in space certainly is commendable. But they have not been bold enough, have not gone far enough. If ever there was a need for national leadership in a vital field, the time is now.

For the past week, we have been crossing the nation by car, talking to people in California, Arizona, New Mexico, Texas, Louisiana and Mississippi whose only connection with missile/space industry is what they read in their local newspapers. It is an opportunity which offers a refreshing perspective.

Criss-crossing the nation by jet aircraft, as most of us in the industry do, one is inclined to forget that the strength of this nation lies in the people who populate the areas between airports. A simple, condescending thought perhaps, but we often are inclined to forget the verities as we stare upwards at our interplanetary fireworks.

The people we talked with are not happy with the clear leadership the Russians have established in space. They are puzzled by it because they have been told often we are following a logical, calculated path in our space ventures. The bartender in Las Cruces, N.M., the farmer in Odessa, Tex., and the service station attendant in Minden, La., share the same feeling. Something is badly amiss. We should be ahead, not behind.

But the field is too technical for them to know what should be done to regain our lost leadership. They will support whatever is necessary but someone must tell them what that is. That is why the need for active national direction is so imperative.

It is not too theatrical to say that our national survival depends upon it.

As one crosses the nation, the feeling is inescapable that somehow we have forgotten the truths that were supposed to be self-evident. Broad, smooth, divided thruways—financed under a multibillion-dollar Federal Highway Program—sweep past wretched huts where some American citizens live no better than those much-publicized Russian unfortunates we hear so much about. The man with the car is better provided for than the man with the horse and plow. Is money for survival more dear than money for concrete highways? The man with the plow will tell you not. But we are not listening.

THIS EDITORIAL is being written in Vicksburg, Miss., important militarily since the days of the Spaniards because of its commanding position on the walnut hills. It was known during the Civil War, you will recall, as the "Gibraltar of the Confederacy."

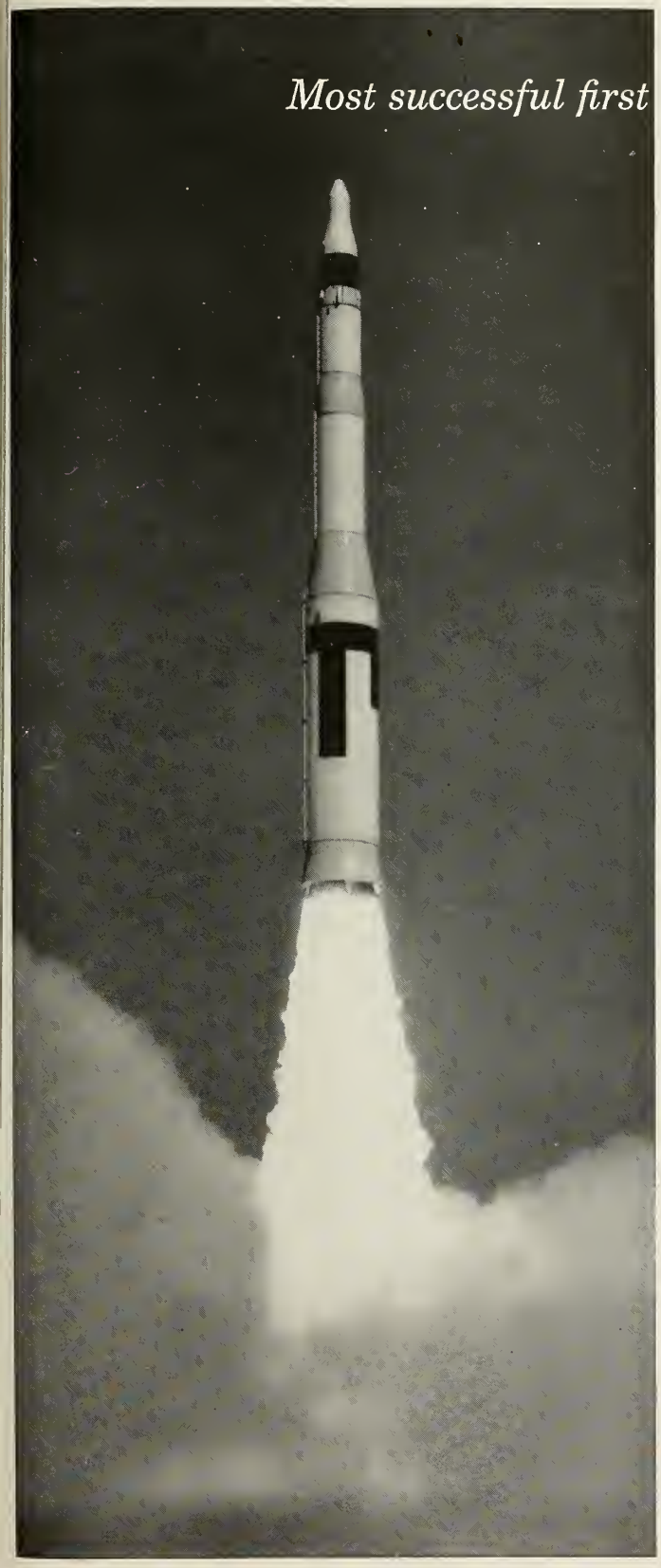
When it fell in 1863 to Union forces after a 47-day seige, the Confederacy's important route to the grain and beef supplies of the southwest was cut.

General Grant said that "When Vicksburg fell, the fate of the Confederacy was sealed."

The high ground is no less important today than it was in the days of General Grant.

If we forfeit the high ground of space to the Russians, our fate as a nation is sealed. The people will support what is required. For the survival of our country, they must be told what it is and then—regardless of its cost in automobiles, Kentucky bourbon or split-level homes—it must be done.

William J. Coughlin



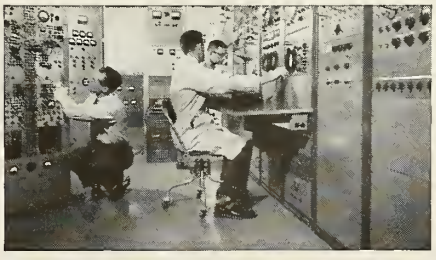
Most successful first flight in missile history

Historic first firing of Minuteman, the U. S. Air Force's first solid-fuel intercontinental ballistic missile. Completely successful, this flight marked the first time in history that so many missile components were tested on initial flight: three rocket stages, full guidance system and nose cone. Compact, quick-firing Minuteman missiles, scheduled for operational status by mid-1962, will be stored ready for instant action in underground silos and on special trains. Boeing is responsible for Minuteman assembly and test, design and development of launch control and ground support systems.

Capability has many faces at Boeing



SKY TANKER. Boeing KC-135 jet tanker refuels bombers and fighters to provide greatly extended range. This versatile Boeing jet is also a military transport. The United States Air Force recently ordered 30 C-135s, cargo-jet version of KC-135.



TESTING. TESTING. Boeing electronic system tests effectiveness of radar and countermeasures systems. Boeing is widely active in electronics—in research, design, manufacture and test, and in the assembly of systems for Air Force's BOMARC and Minuteman missiles, and Dyna-Soar space-glider.

BOEING



He built the strongest roof in the world

This AMF engineer knows what it takes to shrug off megaton forces. He *had* to know because he designed the prototype atomic bomb shelter at Frenchman Flats, the only building that stood up under the force of the atomic bombs exploded there. Well, not altogether—a flange on the door *was* bent.

In order to design the shelter, he had to calculate the effect of the explosion on materials and structures. He had to know how the shock was transmitted through the earth's crust and what effect it would have on the shelter—from beneath as well as from above. And, after the dust of calculating had settled, he had the very practical problem of expressing the results in steel and concrete. He did so, successfully.

Single Command Concept

The solution of this first-time-in-history problem is one more example of AMF's resourcefulness.

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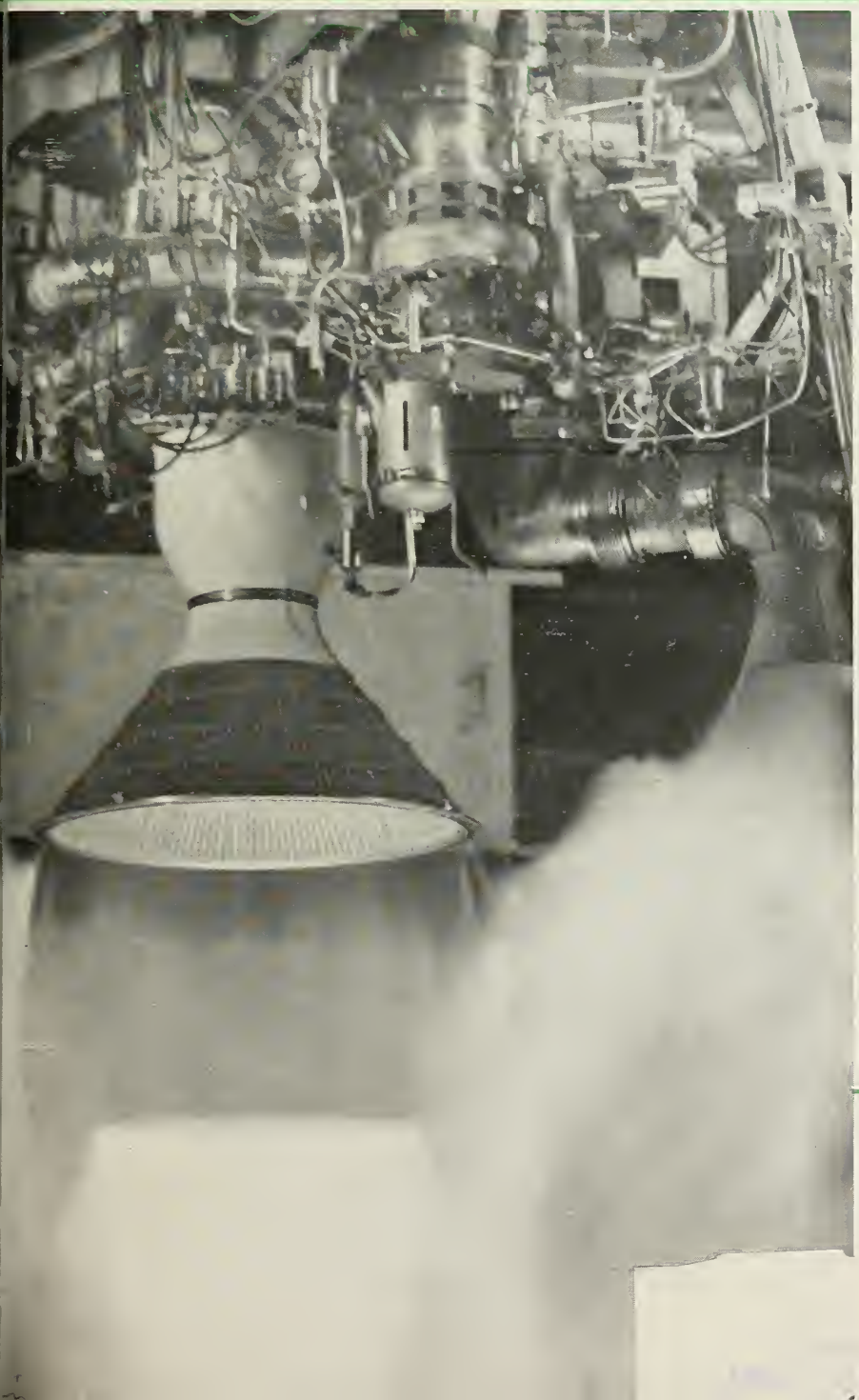
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missiles and rockets

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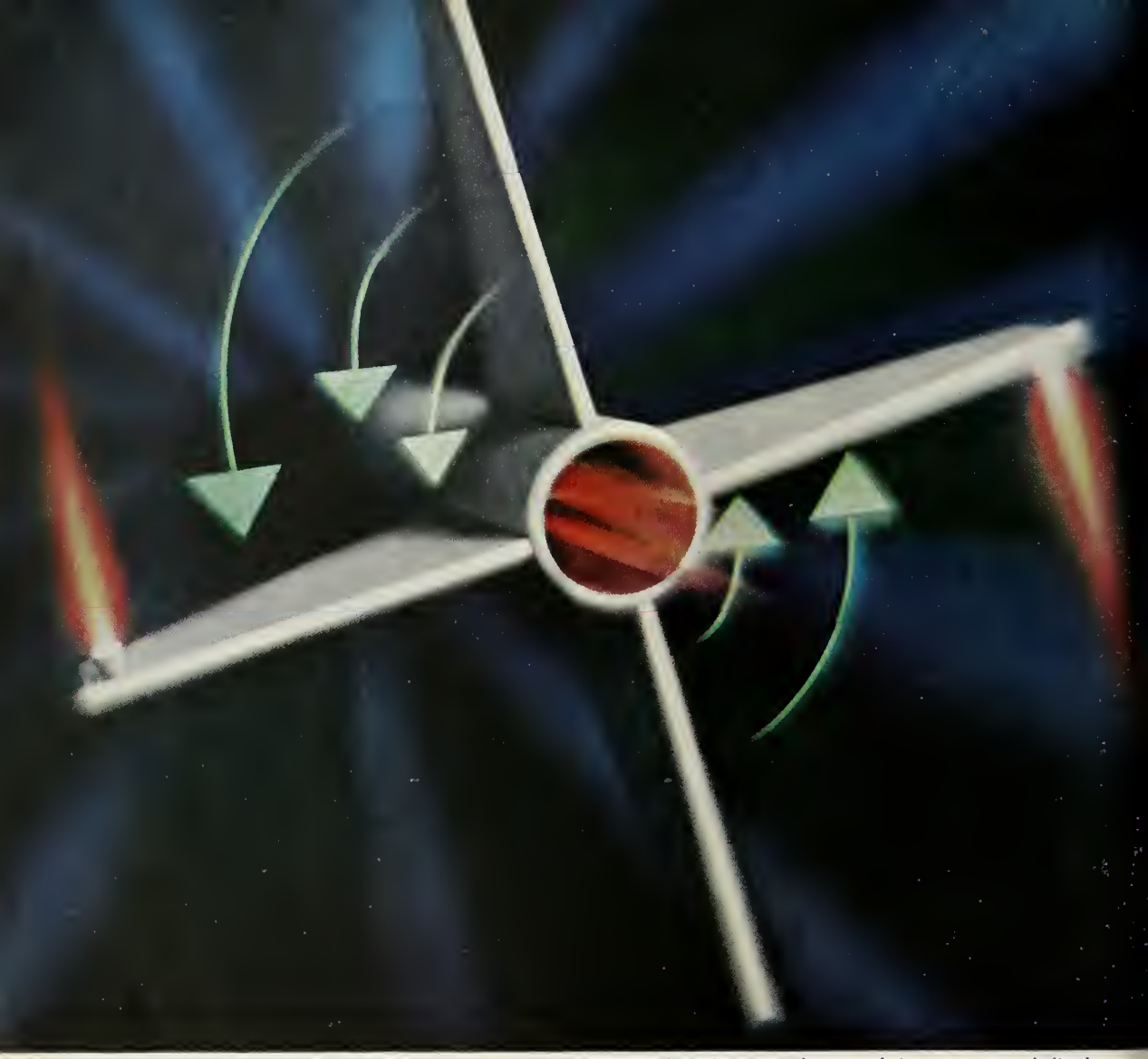


U.S.-British Row Could Develop From Skybolt Uncertainty

- MR-3 Launch In Perspective
- Titan to Get 2nd Stage Skirt
- New Edition— M/R's Astrolog

Firing Titan II 2nd Stage

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Reaction controls at work in space — symbolized.

STEERING GEAR FOR ASTRONAUTS

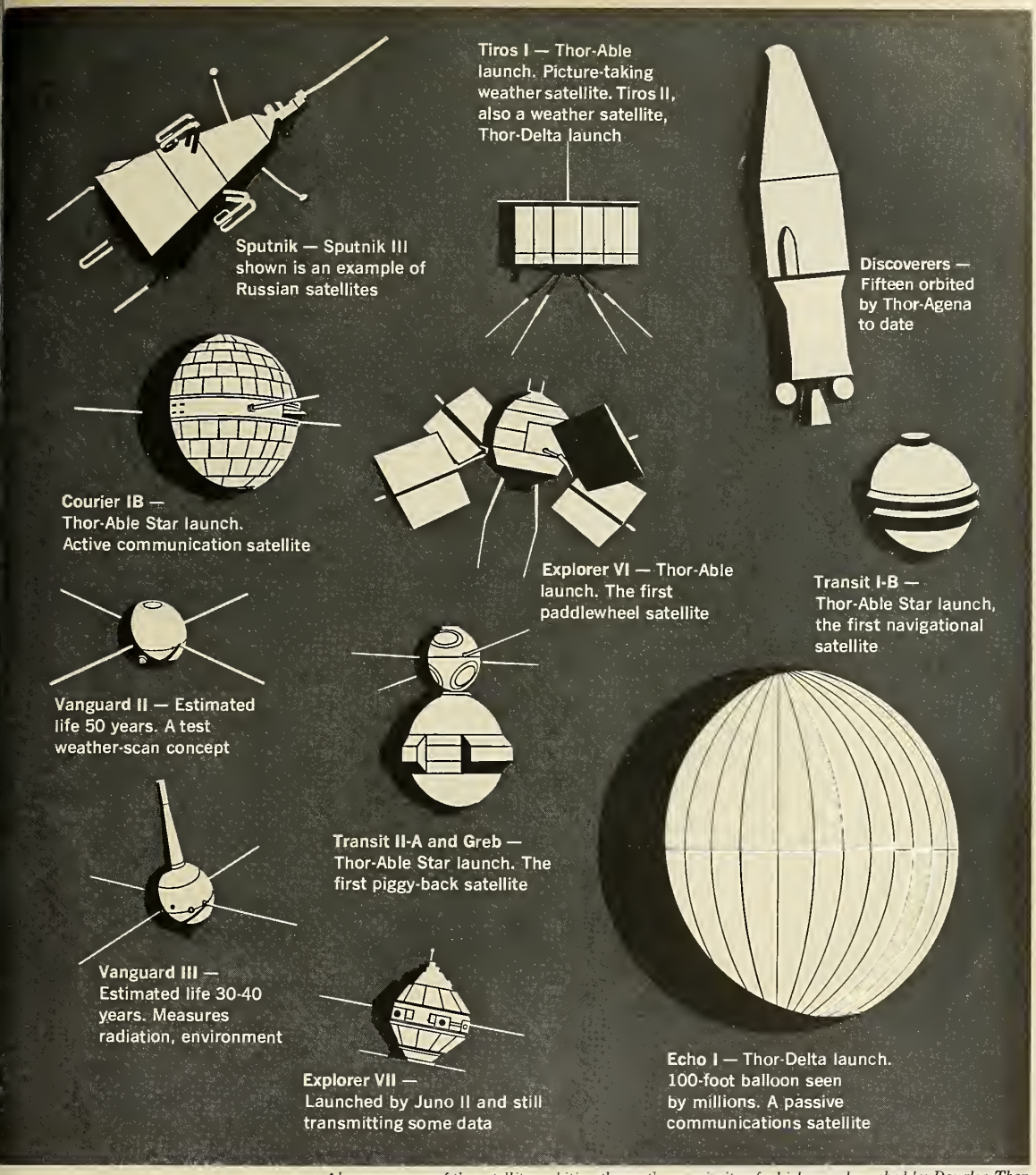
Conventional aircraft control surfaces will not guide space ships and capsules. Rudders, ailerons and elevators find no resistance and hence produce no reaction to their movements where there is no atmosphere. Even at altitudes only half way up, they are sluggishly ineffective.

The accepted answer to a dependable steering mechanism for astronauts is a system of jet reaction controls developed and produced by Bell Aerosystems Company. First used on Bell's own supersonic X-1B several years ago, the system has been greatly improved and adopted for the X-15, the Mercury man-in-space project and other space vehicles.

Through strategically located, low and high thrust (1 to 1500 pound) rocket engines, Bell's reaction controls not only position and guide the ship by controlling the roll, pitch and yaw, but they also provide for orbit changes and retro-thrust. Some of the jets are throttleable while others can be operated in combination to provide the astronaut positive and flexible control.

This revolutionary steering gear for space, available using monopropellants or high energy bipropellants, is just one of many advanced projects which are currently engaging the diversified talents of Bell Aerosystems Company in the fields of rocketry, avionics and space techniques. Engineers and scientists seeking challenging, long-range career opportunities can find them at Bell.

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Above are some of the satellites orbiting the earth, a majority of which were launched by Douglas Thor

The Douglas Thor rocket has orbited more satellites than all other rockets combined!

Of all satellites put in orbit since 1958, 55% were launched by the Air Force-NASA Thor IRBM. In its last 83 tactical and space firings by the Air Force, Navy and NASA, 86% have been completely successful—a reliability inherited from forty years of Douglas experience in aviation and 21 years in missiles and space.

DOUGLAS

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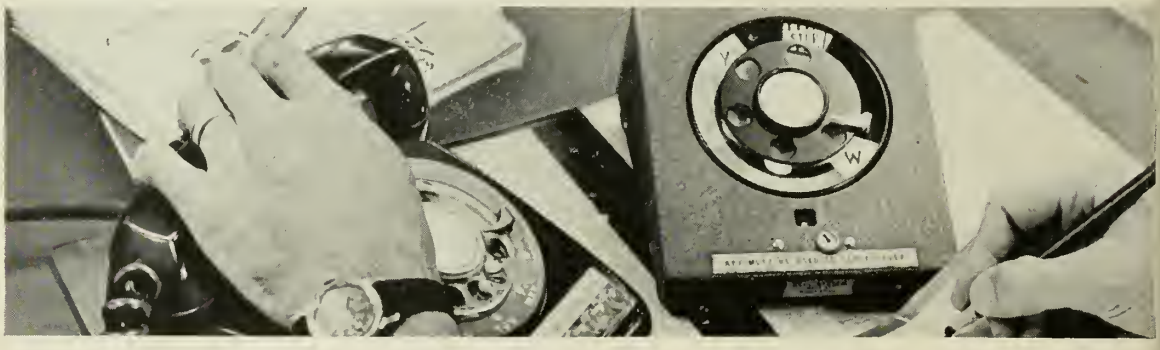
from the reaches of space

Unretouched time exposure shows Echo I communications satellite (long line) crossing heavens right to left. Shorter lines are stars "in motion."



Actual undersea photo of telephone cable off coast of Florida.

to the depths of the sea



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We recently handled the world's first telephone conversation *via satellite*. And we have started development of a world-wide communications system employing satellites.

We developed the world's first undersea telephone cables to speed calls between continents.

When industry and government needed a way of gathering huge amounts of coded information from distant points, we were ready with our vast telephone network and Data-Phone, which transmits at extremely high speeds.

Far in the frozen north, our engineers are putting together the communications system for BMEWS, the nation's Ballistic Missile Early Warning System.

For strategic defense installations, we provide a Group Alert and Dispatching System making it possible for one pull of the dial to ring up to 430 telephones *simultaneously*.

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missiles and rockets

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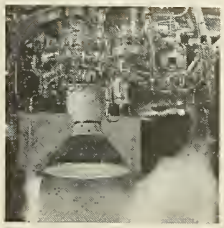
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THE COVER

Titan II second-stage engine is test-fired at Aerojet-General's Sacramento plant. An ablative skirt will be added to the thrust chamber before flight. See report on p. 22.



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Designed for strapdown control applications, this miniature wide angle precision gyro provides accurate and reliable performance in extreme missile environments.

A newly developed high viscosity damping fluid with good low temperature characteristics permits large angular inputs without loss of reference and eliminates the need for paddle type damping devices. Low uncompensated drift levels are obtained through the use of externally controlled adjustments of mechanical mass unbalance and fixed torque drift. A unique torquer with external adjustments makes possible high torque linearity including at the "off null" position. The spin motor will operate satisfactorily from a three phase or single phase 400 cps power supply.

Actual test data taken on a group of these gyros demonstrate the capability of this device as the most accurate and stable control gyro now available. Typical test results include the following average values:

Uncompensated mass unbalance level—0.35°/hr/g avg.; Uncompensated restraint level—0.4°/hr avg.; Torquer linearity 0.017% avg. proportional from 0.1°/sec to 5°/sec.

TYPICAL CHARACTERISTICS

Angular momentum (gm cm²/sec.)	100,000
Operating temperature	180°F*
Torquer scale factor (°/hr/ma)	800
Input angle	Up to 30 degrees
Transfer function (mv/mr)	3.75 at gyro gain of 3.0
Dimensions: lengths	3.56"
body diameter	1.98"
mounting diameter	2.15"
Weight	1.2 pounds

*lower operating temperature as required

Write for complete data

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letters

The Long Sleep

To the Editor:

The statement ". . . we are all asleep," by Lt. Col. Powers (press officer for the U.S. astronauts, when asked in the early morning hours to comment on the Soviet manned launching) in M/R, April 17, p. 15, seems to accurately reflect the attitude of the country with respect to space, missiles, and civil defense. How about reviving "Countdown for Survival," which started off so well in the Oct. 3, 1960, issue of M/R? It might help to wake the sleepers.

David W. Johnston
Washington, D.C.

Missile Safety Courses

To the Editor:

The Aviation and Missile Safety Division of the University of Southern California was quite interested in the reaction (Letters, M/R, April 24, p. 52) of Mr. Ickes, manager of public relations for Aerojet-General Corp., to the announcement of our formal course in missile safety.

The chronological establishment of safety courses is of no practical significance. To be sure, there have been missile safety courses which originated prior to courses conducted at either Aerojet or USC. To allay any false conclusions which may result from Mr. Ickes' letter, we feel it is important to define the purposes of various courses of instruction. A training course is designed to improve one's skill or mechanical ability. The purpose of an educational course is to increase knowledge. Obviously, some knowledge must be imparted in a training course, but this is not the *prime* consideration, as it is in the case of an educational course.

The philosophy behind all the safety courses taught at USC has been the imparting of technical knowledge with examples of specific safety application. The advantage of this philosophy is that a technically educated person will be able to recognize dangerous conditions and take corrective action before an accident may occur. He is also in a better position to successfully determine the *actual* cause of an accident if one does occur and preclude its reoccurrence.

Safety training, on the other hand, only teaches the causes of past accidents; it requires a disastrous history of failures to achieve its goal. The prevalence of this philosophy is evidenced regularly in newspaper accounts of attempted launchings.

A mute consequence of the safety "educational" philosophy is a more effective and reliable weapon system, which is the real purpose of missile safety in the first place. This fact is just beginning to be appreciated.

In these respects, we feel that the Aviation and Missile Safety Division is unique, as is the formal course in missile safety.

Eugene Dimitruk
Lecturer, Aeronautical Engineering
Aviation and Missile Safety Div.
University of Southern California
Los Angeles

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The Countdown

WASHINGTON

Cuba: A Coming Missile Threat?

Some top military men are more worried than ever that Premier Castro's next step in Cuba will be to "import" some Soviet-made missiles. These could be used to terrorize much of Central America—possibly they would be used as a blackmail threat aimed at Miami.

Skybolt Moves Forward

The *Skybolt* ALBM program, rejuvenated at least in part by the Kennedy Administration, is moving forward almost precisely on its original schedule again. B-52 H and RAF Vulcan jet bombers are expected to begin air-dropping the first inert *Skybolts* this summer. Bombers are expected to begin dropping the missiles for hot launchings about next spring. (See page 10.)

No News Is Good News

The Administration is pushing ahead with its plans to stanch the flow of information about U.S. military programs. The Administration argument: Even if the information can't be kept from the Russians if they want it, why make it easier for the Russians to get it. Counter-argument being made: Easy or not, the Russians will get it. The government and the Russians will know—only the voters won't.

Red Missiles May Send SAC to Ice Cap

The Air Force may use remote ice runways in the Arctic for dispersing SAC bombers in the face of the growing stockpile of Soviet ICBM's. A 14,000-foot test runway capable of handling B-52 bombers and missile-packing Century Series jet interceptors has already been built in North Star Bay, Greenland.

Polaris Relay Ship Being Built

The Navy is converting a carrier into a major communication relay ship that could serve among other missions as a key command link with the submerged *Polaris* fleet. The big ship could be used as the relay point for an order to launch if the Navy's land-based *Polaris* transmitters were knocked out.

INDUSTRY

G-D Reorganizing

Missile/space activities and electronics are getting much heavier emphasis in a large-scale reorganization of General Dynamics Corp. Convair-Astronautics will have a new role as a separate division with aircraft activities grouped in what is now the Convair Division. Major management functions headquartered in the San Diego corporate office of Convair are due for transfer to G-D New York offices.

$12 Million More for 3059

Watch for the Air Force to award a $12-million follow-on contract for development of the 1-million-lb.-thrust solid-fueled *Project 3059* booster. Aerojet-General, the prime, has been working on the big rocket under a $4-million contract. The total amount for *3059*, incidentally, almost equals the $15-million increment NASA is asking in the FY '62 budget for solid fuel research.

Polaris A-3 Contract Coming

Navy's Special Projects is due soon to let a hotly-contested multimillion award for the second stage of the 2500-mile *Polaris A-3*. Big question is whether the Navy will buy a filament-wound glass motor case. Hercules Powder has dominated the field. But Aerojet-General recently has acquired a substantial capability in this new technology, along with Grand Central Rocket, in winding filament directly on propellant.

R&D Intelligence

Low-speed tests of a "paraglider" recovery system for the *Saturn C-2* are under way at NASA's Langley Research Center. The 1/6 scale model was developed by North American Aviation's Space and Information Systems Division. . . . Wide-angle camera (880 sq.-mi.-range) aboard *Tiros II* is now taking satisfactory pictures of cloud cover. Trouble with the lens, which was coated by some material during outgassing, has cleared up. . . . One engineer close to the *X-15* says the delayed motor ignitions during the last two flights probably were caused by pilot errors, since there were no failures until ignition prerogative was given to the pilot.

INTERNATIONAL

Blue Water Unveiling

English Electric is expected to unveil its 100-mi-range *Blue Water* May 16 in Britain before taking it to the Paris Air show 10 days later. The British are engaged in a big campaign to sell this solid-fueled tactical missile to NATO.

Pershing to Germany?

COUNTDOWN is told the chances are good West Germany will buy the 350-mile-range *Pershing* tactical missile. Recently, a German delegation of defense officials and Secretary of State Hopf visited Martin-Orlando and reportedly went home impressed with *Pershing*.

Overseas Pipeline

Quelling of the Algerian revolt is believed to have kept France from withdrawing from the European Space Club. . . . Germany may make its decision on joining the club in two weeks. . . . There's a rumor aloft that British scientists may have scored a "breakthrough" in the anti-missile race.

Yuri's Flight Details

Russia soon will submit details of Yuri Gagarin's orbital ride to the Fédération Aéronautique Internationale to claim records for space flight. Details said to be forthcoming: type of rocket engines and configuration, total thrust, launch site, special apparatus used to recover the flight vehicle, how the landing was made and where.

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The Missile/Space Week

Shots of the Week:

The Air Force successfully launched a *Titan* missile directly from a silo in a test of the *Titan II* launch pad configuration.

The missile, a *Titan I* with no second-stage separation or ignition, was destroyed by Naval range safety officers who requested the unnecessary destruction as a test of their facilities.

The launch, called "completely successful," was billed as the final check of a concept designed to reduce reaction time from 15 minutes to a few seconds. Everything in, around and above the silo was wired for collecting data on acoustics, heat and atmospheric pressure that rode out with the missile as it rose from the silo launch test facility. The test provided data on whether the *Titan* in the silo could withstand the acoustics, temperatures in excess of 5000°F, and pressure during the 8 seconds before it emerges from its silo after first-stage ignition.

The launch also checked the missile to the theoretical limits of its structural strength by continuing strong programing signals to the autopilot beyond T+96 seconds.

The bird was allowed to fly for 140 seconds, then destroyed. It reached. about 200,000 ft. altitude and 15 miles distance.

The silo-lift method will be used for the first six *Titan* squadrons. *Titan II* squadrons, using the in-silo facility, will enter the Air Force inventory starting with the seventh squadron.

At Eglin: A *Bomarc B* missile intercepted and destroyed a *Regulus II* target missile streaking at Mach 2, 50,000 feet over the Gulf of Mexico.

At Canaveral: An advanced *Polaris A2X* launched from a land-based pad flew more than 1400 nautical miles.

Morse Stepping Down

Assistant Army Secretary Richard S. Morse, has submitted his resignation to be effective June 1.

The resignation is in line with a decision announced privately several months ago. No successor has been named.

Add Contracts

A $4.8-million contract for final design of a *Saturn* static test stand at Huntsville was awarded by NASA to Aetron, a division of Aerojet-General.

The contract includes procurement and fabrication of technical



S-15 Goes to Work

GAMMA-RAY astronomy satellite (S-15) is lowered into shroud covering upper stages of a Juno II test vehicle preparatory to successful launch late last month. Experiment's objectives are to detect high-energy gamma rays from cosmic sources (such as from our own galaxy and neighboring galaxies including the Magellanic clouds) and map their distribution in the sky. (See M/R, April 3, p. 19, and Feb. 6, p. 24.) Six hours after launch, S-15 began collecting and telemetering data to Minitrack stations. On May 2, period was 108 minutes; apogee, 1111 statute miles; perigee, 301 statute miles; inclination, 28.8°; and estimated life in orbit, 13 months.

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systems and instrumentation for the $10.8 million facility.

Sperry Gyroscope received a $33-million contract for production of guidance systems for the Navy's *Terrier* missile.

Vostok Still Under Wraps

Although the Russians were still trumpeting their man-in-space accomplishment for propaganda purposes, no specific facts emerged on whether it was a winged or capsule-type vehicle.

The party-line newspaper *Isvestia* said only that descent began 5000 miles from the landing point, and took about 30 minutes—prompting speculation that it was a vehicle with aerodynamic surfaces.

It also noted that provisions were made for the pilot to land in the cabin or, if necessary, parachute out in an ejection seat. Which was done in the case of Gagarin remains a mystery.

One significant detail now claimed by the Soviets: Gagarin could have, if necessary, controlled all the instruments on board the ship even though they were preprogramed.

ICBM's Sit Out May Day

May Day was ushered in at Red Square by an impressive array of heavy artillery and tactical weapons but larger weapons of the ICBM class were conspicuously absent.

Biggest of the missiles paraded publicly were estimated by Western observers to be IRBM's with ranges of about 700 miles. All appeared to have been shown in previous May 1 parades.

Although the armaments portion of the parade was the shortest in recent years, lasting about 22 minutes, the speeches emphasized the Soviets' military might. Defense Minister Rodion Malinovsky said the Soviet Union was strengthening "still further" its armed forces and defense capacity.

Soviet cosmonaut Major Yuri Gagarin held a place of honor next to Premier Khrushchev on the reviewing platform.

Boeing Drops 'Airplane'

Boeing Airplane Co., following the lead of a number of other major missile manufacturers, is dropping the "airplane" from its longstanding corporate name.

The company posted $5.9 million in first quarter earnings on sales of $325 million. This compared with earnings of $4 million on sales of $396 million the same period last year. Backlog was $2.8 billion, compared with $2.13 billion at March 31 a year ago.



Teaser in Red Square Procession

BIGGEST MISSILE in Russia's Red Square parade on May Day is shown above. While observers said it did not appear to be anything new, there was some speculation that it could be the new T-5A solid-fueled IRBM.

Dyna-Soar Force Picked

A *Dyna-Soar* test force has been chosen at Edwards AFB to study its operating methods—although no individual pilots have been chosen yet.

Maj. Gen. John W. Carpenter III, commander of the Air Force flight test center, said six pilots, four of them instructors at the school, will start the special course in June.

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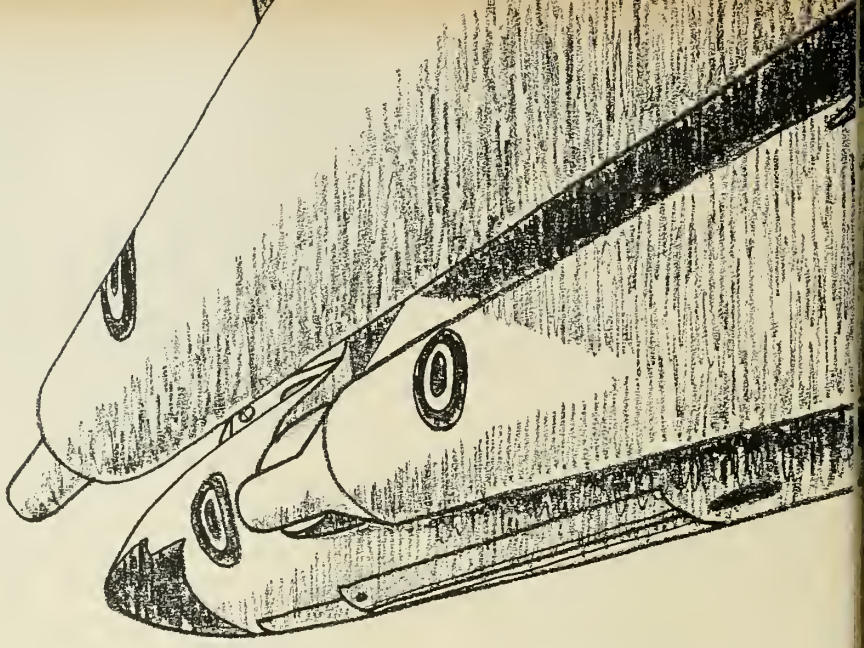
Pyrofuze is a bimetallic product (Patent No. 2,911,504) that at 650°C. allays exothermically to create temperatures up to 2500°C. Used in missile applications as primary initiator, heat source, destructible retainer or support; and as an electrical switching device.

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How Skybolts would look attached to the wings of Britain's Vulcan bomber

U.K.'s strategy is based on delivery by U.S. in mid-60's

Skybolt Uncertainty Haunts British

by James Baar

LONDON — The Kennedy Administration is allowing the *Skybolt* ALBM to become a potential time bomb at the heart of Anglo-American relations.

As of today the 1000-mile range air-to-surface missile continues to be the key nuclear weapon in RAF planning for the last half of the 1960's despite strong political opposition in Britain.

However, unknown to the British public and certainly many British leaders, the *Skybolt* R&D program was all but shelved by the final Eisenhower defense budget. And, under the Kennedy Administration, *Skybolt* has fared only a little better.

Skybolt originally was scheduled to become operational in 1964 when the Air Force directed Douglas Aircraft Corp. to proceed with the R&D program on Feb. 17, 1960.

The Administration authorized the obligation of $80 million for the program in FY '61, a figure which the Air Force considered insufficient to meet the 1964 operational goal. Later, the Administration approved an Air Force plan to increase the funding of *Skybolt* in FY '61 to $150 million.

Meantime, the United States and Britain concluded an agreement under which *Skybolts* would be sold to the British for deployment with RAF V-bombers. The missiles were to be fitted with British nuclear warheads.

• **Does it exist?**—Reaction in Parliament and the British press was loud and cutting.

A typical headline in the London *Daily Express* said: "The Sorry Truth about the Skybolt Deal." A typical Labourite charge made by MP George Brown, Defense Minister in the Labour Shadow Cabinet, was that *Skybolt* did not exist and no one knew when it would.

Behind the charges were three major factors:

—The cancellation of the *Blue Streak* IRBM by the British Government, a move that virtually put the British missile industry out of the big missile business.

—General British chagrin at the idea of tying the major British nuclear force in the late 1960's to an American-made missile.

—The claim by British missile industrialists that they could produce the *Skybolt* themselves.

Defense Minister Harold Watkinson defended the *Skybolt* agreement on the grounds that Britain would get the missile from the United States sooner and cheaper than if a similar weapon were developed by British firms. He also stressed that the *Skybolts* would be purchased outright without any binding strings, thereby maintaining an independent British nuclear force. The Conservative Party's word thus was staked on *Skybolt*.

Then, last December, the Eisenhower Administration cut back the *Skybolt* R&D program. The Air Force was directed to spread the $150 million authorized for FY '61 alone over FY '62 as well.

This meant in the opinion of experts close to the program that there was no chance of the missile being operational in 1964 or possibly even 1965. The stretchout was vaguely indefinite.

• **On a limb**—President Kennedy reversed the Eisenhower decision at least in part. He added $50 million to the program for FY '62.

The Kennedy addition gave the program a fighting chance to meet the 1964 goal, but only if large infusions of money are made over the next two fiscal years. Almost all of the margin for error—almost all insurance—was thrown away.

Moreover, the Kennedy Administration removed at least for the present two future launching platforms for *Skybolt*—the B-70 and the nuclear-powered aircraft. Therefore, the usefulness of the weapon in the United States is accordingly decreased.

Not so in Britain.

The entire British strategic force is being molded toward the development of *Skybolt*. Production of Victor bombers, which cannot be fitted with *Skybolts*, is being cut. The production of Vulcans, which can carry the missiles, is being increased.

By the mid-60's the RAF is expected to have about 200 Vulcans that can be deployed in Britain or dispersed at overseas possessions. They will be waiting to receive their deadly loads of *Skybolts*—without which they will be highly vulnerable to enemy air defenses.

The question is: will the *Skybolts* be ready? ⌘

Senator hits press agents . . .

MR-3's Import Distorted by Publicity

Bad weather scrubs first launching attempt and technical troubles extend delay; McDonnell gets contract for six vehicles

by Jay Holmes

CAPE CANAVERAL—America moved toward its first manned ballistic space shot in an orgy of publicity that threatened last week to obscure the fact that *Mercury Redstone 3*—even if successful—would be only a flea hop compared to Russia's manned orbital flight.

Roughly 500 newsmen jammed the Cape to cover the long-delayed event for newspapers, radio and television. Their arrival a week ago Sunday turned out to be premature.

The shot—scheduled for Tuesday with Astronaut Alan B. Shepard aboard—was scrubbed because of bad weather and rescheduled for later in the week. This left the newsmen with little to do but report the movements of Shepard (who had nothing to do but wait) and interview visiting congressmen and each other.

So great was the fanfare that Sen. John J. Williams (R-Del.) urged the Kennedy Administration to cancel the shot and reschedule it for some undisclosed time—so that "another American fiasco" comparable to what happened in Cuba could be avoided. The senator blamed the big *Mercury* buildup on government press agents—most of them holdovers from the Eisenhower Administration.

"It is long past the time when Administration officials should stop talking about their great plans," Williams declared on the Senate floor, "and devote more of their efforts toward constructive work in getting their job done."

Newsmen on their toes at the Cape promptly asked Chairman Overton Brooks (D-La.) and 16 members of his House Space Committee who had journeyed here for the occasion what they thought about the burning publicity issue. The reaction was mixed.

Said Brooks: "What's wrong with it?" He obligingly posed for pictures with Shepard.

Said Sen. Howard W. Cannon (D-Nev.) of the Senate Space Committee, who flew in for a day in a T-33 jet trainer: "I don't see why we have to make it such a major production, particularly when there are so many things that can go wrong. . . ."

Others generally agreed that in a free society, with a free press, the buildup to the shot was inevitable.

• **Countdown begins**—The *MR-3* operation required that there be no more than an 18-knot wind, 3-ft. waves maximum and no more than 40% cloud cover over the recovery area 290 miles downrange. The weather forecast on Tuesday called for a squall line to move through the Cape area during the night, with a 50-50 chance the skies would clear a few hours after daybreak to the required condition.

Mercury Operations Director Walter C. Williams decided to take the chance on Monday and the countdown proceeded normally for launching the 2500-lb. bell-shaped capsule. The final phase, 390-min. countdown began at 12:30 a.m. Tuesday. It proceeded until T-290, when the storm broke over the launch pad and a hold was called. The count was resumed at 3:50 a.m.

The 37-year-old Shepard, who had been awakened at 2 a.m. along with his backup, Lt. Col. John H. Glenn, breakfasted and went through a physical exam. Four sensors and a respiration gauge were attached to his body and a wired thermometer was inserted in his rectum. Shepard then donned his pressure suit, a 15-minute operation requiring the help of a technician.

He remained in Hangar S, five miles from the pad situated not far from the Banana River. Shepard asked Glenn to inspect the interior of the capsule for him and a hold was called at 4:15. However, for some undisclosed reason, Glenn did not make the inspection and the count was resumed at 4:27. There was another four-min. hold at 4:51.

The plan was for Shepard to leave Hangar S and enter a special transfer van at T-185. During that time, a new weather report showed conditions had worsened. Shepard remained in his quarters. The count continued to T-140 as the storm moved out to sea. Skies were partially clear over the Cape at 6:30 a.m.

There was another hold to 7 a.m., when word came that rain was falling heavily at Grand Bahama Island 75



ASTRONAUT Alan Shepard was told three weeks ago he would take MR-3 ride—then found out he had to wait.

miles southwest of the recovery area. Williams thereupon scrubbed the shot.

The minimum recycling time was announced as 48 hrs. However, because of a series of minor technical difficulties, and the need of a complete booster-capsule check, Williams ordered the launching delayed until at least Friday. During the LOX purge, a small tube snapped on the *Redstone* and had to be replaced. Also, one of the EKG biomedical telemetry circuits in the capsule acted up.

Williams told reporters that if weather should be bad on Friday, a Saturday launching would be possible, but if a second recycling should be required after pumping LOX in on Friday, workers at the Cape would be given Sunday off and the count would be resumed Monday for a Tuesday launch.

During flight preparations it was announced that McDonnell Aircraft Corp., prime to NASA for the *Mercury* capsule, had received a contract for six Mark II *Mercury* vehicles with a preliminary expenditure limit of $2.5 million.

• **Some contributors**—Information also was made available on contributions to the program by some of McDonnell's 2000 subcontractors. Here are a few:

• Radioplane Division, Northrop Corp.—Developed and tested the parachute landing system, which consists of a 6-ft.-diameter conical-ribbon drogue chute, designed to deploy at 21,000 ft. altitude to stabilize and decelerate the vehicle to 160 knots true air speed, and a 63-ft.-diameter ringsail main chute, designed to open first to 10 ft. diameter for four sec. and then all the way, to reduce speed to 30 ft./sec. A second main chute is installed as backup.

Radar chaff is ejected when the drogue chute deploys. On main chute deployment a Sofar (Sound fixing and ranging) bomb falls into the ocean and explodes to help the Navy find the capsule in a hurry. On impact, a dye marker is released to aid the visible search. The dye includes shark repellent.

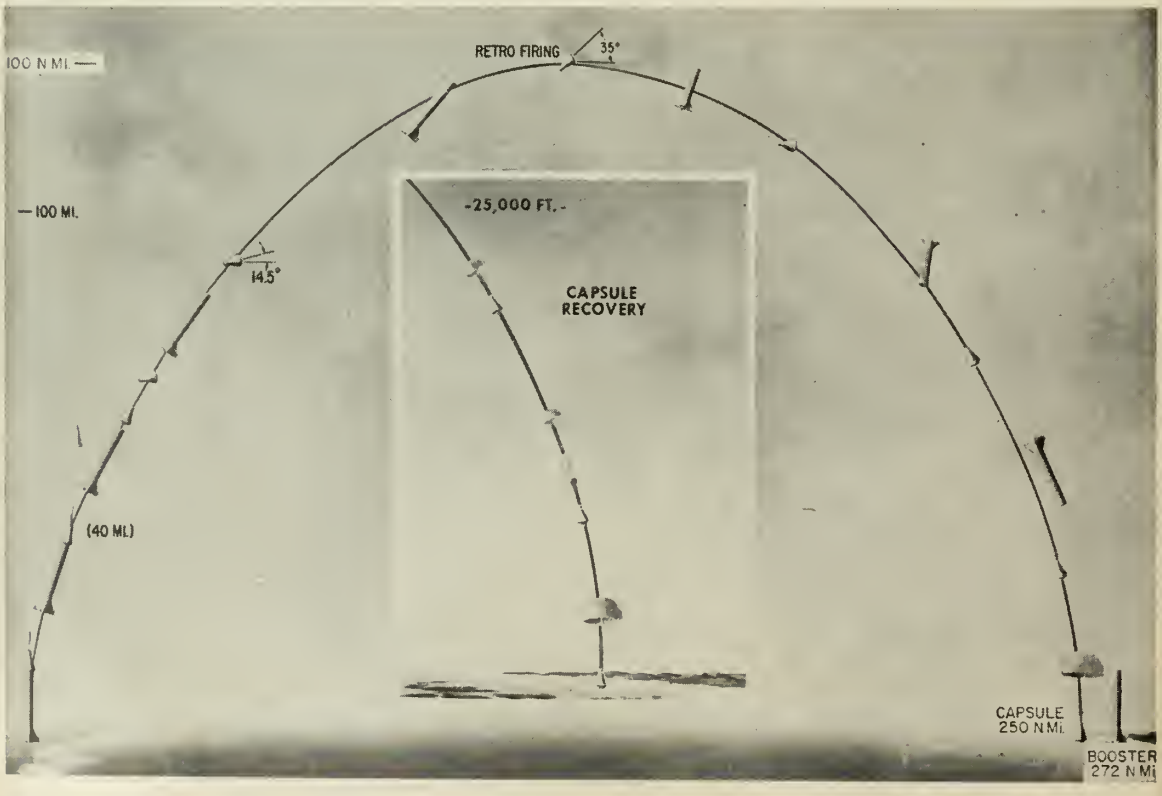
• Minneapolis Honeywell, Military Products Group—Developed two major capsule systems, three other components and two major GSE items. The attitude stabilization and control system, gyro-referenced, generates command signals to hydrogen peroxide jets that maintain capsule in desired orbital position and position it properly for re-entry. The attitude and rate-indicating system gyroscopically senses attitude and gives the astronaut a roll-pitch-yaw visual indication necessary for manual control.

The earth-path indicator is a dead-reckoning computer that continually shows astronaut his position and where he would land if ejected from orbit. The humidity indicator senses conditions in capsule interior. The explosive release system for the escape hatch allows severing of bolts holding the hatch, if desired after the capsule impacts or while it is being picked up by helicopter.

GSE items are a hydrogen peroxide servicing trailer and checkout equipment for the attitude stabilization and control system. Honeywell also conducted considerable human factors research.

• Atlantic Research Corp. — Provided two types of solid-propellant rockets. The larger rocket, generating 860 lbs. of thrust for 1½ sec., jettisons the escape rocket superstructure either after use to allow parachute deployment or after booster burnout, when the escape rockets are no longer needed. The smaller rocket, generating about 415 lbs. thrust for a fraction of a second, is used in a cluster of three—called the posigrade package—to pull capsule forward from booster after separation.

• Thiokol Chemical Corp., Elkton Div.—Provided cluster of three retro rockets 15.5 in. long and 12 in. in diameter with fiberglass-plastic nozzles. Heater blankets keep rocket motors warm during assembly on launch pad so as to limit temperature range during flight and increase reliability. ⁂



MR-3 FLIGHT PATH will take astronaut to altitude of 115 mi. and distance of 290 mi. Time-in-flight will be 15.5 min.—with g-loadings of 6 during launch and 11 during re-entry. Weightlessness will last 5 min. at apogee of trajectory.

Relatively Small Budget Boosts Urged

House groups add funds for more missile-carrying planes and ships and modest increase for NASA; Senate panel told of costly labor troubles

HOUSE COMMITTEES this week put themselves on record as favoring only relatively minor increases in Administration budget requests for the Defense Department and space.

Meantime, the Senate Investigations Subcommittee continued to open to the public the record of labor walk-outs, strikes and slow-downs that have cost the Air Force ICBM base-building and missile programs months in lost time and millions of dollars.

The House committees' actions did not give encouragement to advocates of large increments to the U.S. missile and space programs.

Usually maximum increases to authorization bills are made in the House and trimmed in the Senate. However, this year the pattern may be reversed—at least in connection with the space program.

The White House is expected to make some recommendations—possibly sizable ones—for an increased space effort in the near future. The Senate Space Committee is waiting for them before acting on the NASA authorization bill.

• **Some additions**—The House Armed Services Committee approved a defense authorization bill that left President Kennedy's request for $3.4 billion for missile procurement unchanged.

However, the committee added $337 million for procurement of 15 more B-52 missile-carrying bombers and 16 B-58's, reversing the Eisenhower-Kennedy budget decision to end procurement of Air Force bombers entirely. The increase brought to nearly $5.5 billion the procurement authorization for all military aircraft.

The committee also added $10 million to the Navy's $2.9 billion shipbuilding authorization and directed that the addition be used along with requested funds for three conventionally powered missile frigates to build two nuclear-powered missile frigates instead.

The House Space Committee added $88.7 million to the $1.2 billion requested by Kennedy for NASA—still nearly $100 million less than NASA sought from the White House earlier this year.

The committee voted the extra authorizations and announced them before completing action on the entire bill. But several members said no further sizable increases are expected.

Earlier, there had been talk in the committee of boosting the NASA budget to $1.5 billion or higher. Some members also had hoped for White House support for new major increases in the light of the Soviet triumph of launching the first man into orbit last month.

The biggest slice of the committee-approved increase went to *Apollo*—NASA's proposed post-*Mercury* man-in-space program.

Apollo received $50.2 million, boosting its authorization to $79.7 million. The breakdown of the addition: $42.6 million for additional high-speed reentry research and other related projects, $5 million for advanced tracking facilities and $2.6 million for salaries. It was not immediately apparent whether any of the money would be used for hardware.

The committee added $23.5 million to the *Rover* nuclear booster R&D program: $8.5 million for long-lead-time non-nuclear rocket components and $15 million for construction of an additional engine test stand in Nevada. The increase brought the total NASA *Rover* authorization to $51.5 million.

Finally, the committee added $15 million to the bill for solid propellant research. This was all that NASA would agree that it could use, despite committee urging.

• **Unions assailed**—The Senate Investigations Subcommittee called representatives of both management and labor to testify on the rash of labor troubles that has plagued missile bases and test sites.

One contractor—Henry Gable, president of Gable Electric Service of Dallas, Texas—said labor slow-downs, walkouts and strikes have done more harm to U.S. missile programs at Cape Canaveral than the Communists ever could do.

He specifically aimed his attack at Local 756 of the International Brotherhood of Electrical Workers at the Cape. However, he praised the IBEW national union. He said it did not approve of the local's actions.

Subcommittee Chairman John McClellan said the local union's behavior "borders almost on subversion."

Max Lasky, administrative contracting officer at the Cape, said "the Electrical Workers, Iron Workers, and Pipe Fitters have been the unions which have caused most labor difficulty at the Cape."

He testified that when he refused to approve overtime for a job that did not require it he received unsolicited sale offers, unordered sod and cinder blocks and abusive phone calls.

Edwin R. Brown, executive secretary of the Central Florida Chapter of Associated General Contractors of America, said that the Air Force and Army have abetted the unions by remaining neutral and pressing contractors to get on with jobs or face contract cancellation.

"The unions in this area have been acting like spoiled children," Brown said. "Although they get everything they want, they still ask for more."

He added that because the military services have refused to intervene, the unions have "shown neither conscience nor patriotism in achieving their own selfish ends."

It was against the background of testimony such as this that the committee learned that a $3.50-an-hour electrician at the Cape made $647 one week because of overtime made necessary by labor difficulties. The subcommittee noted that this was $127 more a week than the salary of Defense Secretary McNamara. ⌘

Key House Committee Budget Boosts

(in millions)

For the Air Force	
15 missile-carrying B-52's	
16 B-58's	*$337*
For the Navy	
2 missile frigates (for nuclear power)	*$10*
For NASA	
Apollo	*$50.2*
Rover	*$23.5*
Solid fuels	*$15*

Fading moon hope...

Overtime Won't Help Speed Saturn

NASA men see no chance of cutting mid-1964 operational date —although big booster is moving toward fall flight

HUNTSVILLE, ALA.—*Saturn*—America's only entry in the race for the moon —is now moving hopefully toward a first flight test this fall. But program managers see no chance of speeding up the big booster's mid-1964 operational date.

They contend that even with the authorization of additional overtime (the average work week is now 47 hrs. with some critical areas ranging up to 54 hrs.) any further compression in the tight schedule leading to the first few flights would be "academic."

Their appraisal generally confirms President Kennedy's gloomy prediction that "*Saturn* is still going to put us well behind . . . regardless of how much money we spend. . . ."

However, some officials connected with the program are optimistic as to how far the U.S. is behind Russia. These officials feel that the American program lags no more than six months—even in the face of reports that the booster which put Russia's first man in space was of 1.5-2 million lbs. of thrust, which equals or outclasses the 1.5-million-lb.-thrust *Saturn*.

Regardless of how the race stands today, a formidable amount of work lies ahead for the *Saturn* program. Coming up is a full-duration firing of *SA-1*—the first flight version—before the eight-engine booster is taken down from its static test stand here and shipped by barge to Cape Canaveral. The *SA-1* is scheduled to arrive at the Cape in about three months. Launching may be in October.

The *SA-1* stage passed muster in a 30-sec. static firing April 29. The next tests here will include firings of 30 sec. and one for a full 120-sec.-plus. Prior to shipment to the Cape, the rocket will undergo five weeks of mechanical testing of about 10,000 items on 16 subsystems, and another four or five weeks of electronics testing and flight simulation.

• **Critical engine**—The first launching—as well as the next two under present plans of NASA's Marshall Space Flight Center—will have dummy *S-IV* and *S-V* upper stages. The dummy *S-V* is now en route to the Cape along with a prototype booster on a shakedown cruise of the *Saturn* barge Palaemon.

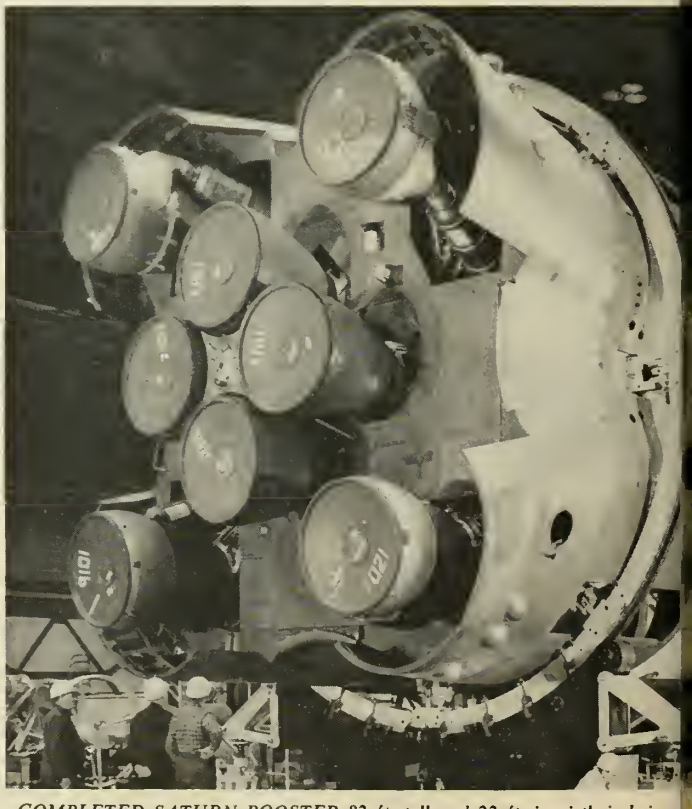
The *Saturn* program is operating on the basis of unlimited overtime in critical areas. NASA Administrator James E. Webb reported last week that the work week of the entire *Saturn* team at Huntsville has averaged between 44 and 48 hours a week since NASA took over technical direction in January, 1960.

Since January, 1960, with the approach of static testing and the first flight test, the average has been 47 hours a week. In the critical areas of fabrication, assembly and testing, the average work week has ranged as high as 54 hours.

Webb said the key factor in the schedule beginning with *SA-4* is the delivery of the hydrogen-oxygen *LR-115* engines (designated *RL-10* by NASA). Pratt & Whitney, the engine contractor, has both shop and test stand employes on a three-shift basis to take maximum advantage of existing facilities at its plant.

• **At $334 million**—Total cost of developing the *Saturn C-1* through its series of 10 R&D flights is expected to be about $1 billion. By June 30, $334 million will have been spent on the project, including $230 million in the current fiscal year. Former President Eisenhower's FY '62 budget called for spending $250 million to carry on the *Saturn C-1* toward a mid-1964 target date for making the vehicle operational.

The first revision of the budget by President Kennedy, submitted to Congress March 28, called for addition of



COMPLETED SATURN BOOSTER 82 ft. tall and 22 ft. in girth is being taken to Quality Division for checkout at NASA-Huntsville Center.

$78 million to begin developing the *Saturn C-2* in a seven-flight program between 1964 and 1966. The biggest single item in the *C-2* development will be a $56-million start on the 800,000-lb.-thrust *S-II* stage.

Most of the staff of Marshall Space Flight Center, of which the nucleus is 80-odd former Germans who developed the *V-2* with Center Director Dr. Wernher von Braun at Peenemunde, is working on *Saturn*. Total employment at Marshall is expected to be 5500 by June 30. A further increase of 450 is provided in Kennedy's March 28 budget revision.

Nevertheless, more than 80% of the money spent on *Saturn* is on contracts with industry—for parts, services, construction and subsystems of increasing size. Only the *S-I* stage is being developed in-house, and even that will be turned over to industry for production after the first 10 R&D vehicles are produced at Huntsville.

In preparation for turning over the whole booster, the Marshall Center is contracting out bigger and bigger components of the vehicle in the latter portion of the R&D program. Chance Vought Corp, recently won a $2 million contract to manufacture 42 tanks of 70 in. diameter for vehicles 6 through 10.

• **Milestones ahead**—Richard B. Canright, chief of *Saturn* class vehicles at NASA headquarters, lists these as the milestones to be accomplished in FY '61:

—Static testing of the protoype *S-I* stage in configuration close to flight configuration at about the expected flight thrust of 1.32 million lbs. and duration of 125 sec.

—Completion of assembly of the first two flight vehicles (*SA-1* in January and *SA-2* in June.)

—Beginning of dynamic tests on the new Dynamic Test Stand. (The stand will not quite be ready for use with *SA-1*. It will be checked out beginning in June with a prototype.

—Static tests of the Pratt & Whitney *RL-10* engine at the specified thrust of 15,000 lbs. and duration of 600 sec.

—Fabrication and checkout of ground support equipment for transportation of the *S-I* stage, qualification of the barge Palaemon and provision for fueling, checkout and launchings from the first *Saturn* launch pad on Complex 34 at Cape Canaveral.

Canright lists these as accomplishments planned for FY '62:

—The first two launchings, *SA-1* in the fall and *SA-2* in the winter or spring.

—Beginning of development of the *S-II* stage, which will increase payload capacity to about 2½ times that of *Saturn C-1*.

—First static firing of the Douglas *S-IV* stage.

—Completion of assembly of *SA-3* and *SA-4*, with the beginning of an increase in the rate of assembly to make ready for the more rapid launching schedules planned for fiscal years 1963 and 1964.

—Full qualification testing of the Rocketdyne *H-1* engine for manned flight and preliminary flight rating test of the P&W *RL-10*.

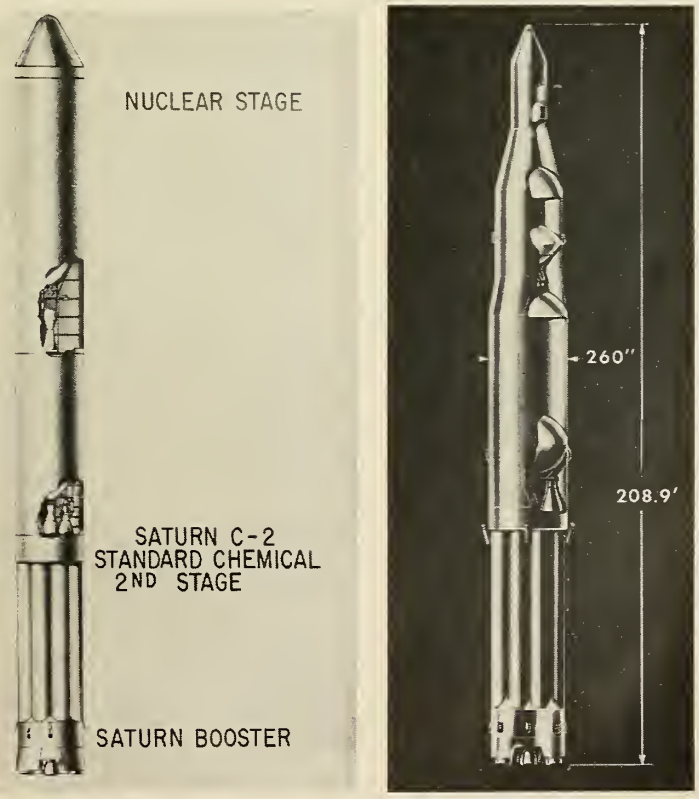
—Design modification of GSE as a result of experience and requirements for the more advanced, two-pad Complex 37.

After the *SA-1* comes down from the static test stand, the *SAT-1* will go back up for a series of special-problem tests. One of the first will be a test of *Saturn* engine-out operation. At one of the inboard engine positions, the *SAT-1* will have an old test engine that has been used for more than 5000 sec. Its propellant lines will be cut off.

One major hurdle will remain until the bird is flown. No one will be sure until then how it stands up on passage through the sonic region. ⌘



ABOUT $1 BILLION will be spent to perfect Saturn C-1 through 10 R&D shots.



UPPER STAGES FOR SATURN C-2 are still being decided. Configurations are for nuclear (left) and 800,000-lb.-thrust chemical second stage.

AT&T, GE File Conflicting Space Communications Ideas

A BATTLE began shaping up last week when two industrial giants filed with the Federal Communications Commission their ideas about the way to set up a commercial space communications system.

The American Telephone and Telegraph Co. proposes that a combine of message-sending carriers and international agencies develop and own the communication satellite facilities.

On the other hand, General Electric Co. doesn't feel that the message-carrying carriers have a vested right to all means of communication. The company recommends that "safeguards should be established to assure that no one communications carrier or aerospace corporation could dominate the firm. . . ."

Both companies want to provide a microwave relay service to all licensed communication carriers for global transmission of telephone, telegraph and communications traffic by means of a space satellite system.

In an apparent answer to GE's newly formed subsidiary, Communications Satellites, Inc., and to similar ventures into commercial satellites by companies unregulated by FCC, AT&T maintains that "ownership participation by others than the carriers providing the communications services would not be necessary or desirable."

Turning a conciliatory glance at GE, AT&T said that "manufacturers and suppliers of satellite equipment and launching facilities will produce the satellites, build the ground stations and supply the rockets, etc." However, AT&T holds that the carrier combine "should have control over the choice of the equipment to be used." ⁂

financial

Lear Inc.—Sales and earnings were the highest in company history. Total sales reached $90.98 million, compared with 1959 sales of $87 million. Operating earnings were $2.8 million, which sales of certain assets raised to $3.6 million. Actual operating earnings were up more than 17% over 1959's total of $2.4 million. Backlog at year end was $78 million, $2 million greater than that at the end of the previous year.

General Telephone and Electronics—Revenues and net sales for the first quarter were $287.7 million, slightly below the corresponding 1960 period. Net income totaled $15.5 million. The manufacturing operations income portion of this amount was less than a year ago, the GTE chairman said. The company announced plans to invest approximately $269 million in new plant and equipment in 1961, and "at least" $2 billion over the next seven or eight years. GTE manufactures communications systems for *Minuteman* and *Polaris* missile-launching subs, MOBIDIC computers and electronic countermeasures systems.

The Martin Co.—Sales rose to $197.9 million for the quarter ending Mar. 31, compared with $140.4 million the same time last year. Earnings were $4.9 million, compared with $3.5 million in the previous year's first quarter.

The Gabriel Co.—Despite a decrease in sales—from $7.7 million the first quarter last year to $6.7 million this year—earnings totaled $140,953 million, compared with $34,734 million.

Chance Vought Corp.—Income for the first three months amounted to $949,270, compared to earnings of $883,162 for the corresponding period in 1960. Sales slipped to $45.5 million, compared with $62.6 million.

North American Aviation—Sales and other income for the six months ending March 31 totaled $573.7 million, compared with $498 million the same period last year. Earnings came up $11.76 million, compared with $11.63 million in last year's six-months period.

American Bosch Arma—Sales for the first three months showed considerable improvement over the same period last year, although income dropped. Income was $612,946 on sales of $34.6 million, compared with income of $664,905 on sales of $32.6 million during the same period in 1960.

Lockheed Aircraft Corp.—First quarter net earnings of $4.4 million, up $1.7 million from a year ago, were reported on sales of $336 million, down $4 million from the same period last year. Backlog amounted to $1.27 billion, up from $1.11 billion a year earlier and $1.22 billion at year-end 1960. Satellites, space research and missiles accounted for $183.7 million of the sales—more than half the company's business.

Republic Aviation Corp.—Sales for the period ending Mar. 31 amounted to $85.7 million. Net income was $2.7 million. This compares with first-quarter sales of almost $35 million and net income of $498,000 for the previous year. The tremendous increase in sales was attributed to increased deliveries of the F-105D fighter-bomber.

General Precision Equipment—Preliminary figures for the first quarter, 1961, showed sales of $62.9 million, up 13% from 1960's first quarter. Backlog at Mar. 31 was $171.8, compared with $181.9 the same time last year. Income for the period was $1.3 million, up from $1.2 million in the first quarter, 1960.

expansions

DOUGLAS AIRCRAFT CO. has opened a $450,000 liquid hydrogen laboratory to test materials and components for use with cryogenic fuels. Facility capabilities include burst-testing at up to 20,000 psi and flow-rate tests of 2000 gallons per minute of LH_2 at pressures up to 125 psi. Compression and stress tests also are being conducted on materials immersed in liquid hydrogen at up to 60,000 lbs. force in either direction. Douglas has a NASA contract to develop the *Saturn S-IV* upper stage.

VITRO CORP. and Selenia S.p.A., a Raytheon Co. subsidiary, have formed a new company in Italy for the design and installation of missile systems and other electronic equipment. The new company, headquartered in Rome, will be known as Vitroselenia.

ATLANTIC RESEARCH CORP.'s new experimental radiation laboratory is going into operation this month at the company's Alexandria, Va., headquarters. The $150,000 lab will be used for experiments with waste products from atomic reactors, radiation damage studies, and investigation of solid-propellant combustion using isotopes as tracers.

IMM INDUSTRIES INC. has been formed by Lewis W. Imm, past president and founder of Librascope. Imm Industries will concentrate on logistics and control of weapon systems, military information processing, navigation and control of air and space vehicles, and commercial projects. The new company is located in North Hollywood, Calif.

(Continued on page 46)

The blueprint . . .

How DOD Will Revise Its Budgeting

THE DEFENSE DEPARTMENT is moving toward an extensive revision of its budgeting and planning processes.

The master blueprint for this revision is a paper written by Defense Comptroller Charles J. Hitch. He began circulating it in official Pentagon circles about the middle of last month.

The paper clearly reflects many of the ideas expressed by Hitch in his recent book, "The Economics of Defense in the Nuclear Age."

Hitch circulated the paper as a proposal. However, except for adjustments that may be found necessary, it is expected to form the outline for Pentagon budgeting procedure during the Kennedy Administration.

Because of the paper's obvious importance, M/R is publishing it in full.

by Charles J. Hitch

THE FUNDAMENTAL objective of the new Programming Office in the Comptroller's Office is to integrate the planning and programming and the financial management functions in order to provide better tools for decision-making by the Secretary of Defense and his military advisors; and to create a planning and programming/financial management system that is keyed to continuous program decision-making and not just geared to the annual budget cycle.

In such a system, not only would budget decisions be program decisions, as they inevitably are now, but program decisions would be budget decisions. That is, decisions to embark on programs would be explicitly decisions to provide the resources required to carry them out.

One important effect of such a system would be to reduce the wastes that have resulted from the fact that our plans and programs for future years have so often over-reached our resources and budget availabilities, with consequent necessity, in budget review after budget review, of killing, curtailing or stretching out uneconomically, programs on which vast amounts have already been spent.

We need an economically realistic future program so that long lead decisions on program components will have a reasonable chance of turning out to be right. To develop such a program, it is essential that the decision makers have before them the total cost implications of alternative programs—not only total in the sense of cutting across appropriation categories, but also in the sense of being projected over the life of the program, or at least projected forward over a 5-year period.

• **Time needed**—Another important effect of such a system would be to allow us to get away from the arbitrary imposition of financial ceilings early in the budgetary process before major program decisions have been made, and therefore, independently of such decisions.

Our ultimate goal cannot be achieved within a few months. However, we do want to go as far as we can in this direction in the decision-making process for the FY 1963 budget. The procedure we want to follow in the development of the FY 1963 budget, and its relationship to the longer run objective, in outline, is as follows:

The traditional budgetary process will be divided this year into a programming phase (June to September) and a budgetary phase (October and November). During the programming phase the Secretary, with his military advisors and his staff, will examine a broad range of alternative programs and make decisions that will form the basis for guidance on the preparation of the budget. During the programming phase, attention will be focused on choice from among alternative programs to achieve our national security objectives. For this purpose, cost and effectiveness comparisons will be made using largely statistical cost factors rather than the detailed information that must be submitted in support of the budget submission.

The subsequent budgetary phase will concentrate on funding requirements to carry out the programming decisions. Because the programming phase is the major innovation, I will explain it in some detail.

First, general policy guidance will be provided by the revised Basic National Security Policy paper which is now in preparation and which will be reviewed by the Secretary and his principal advisors in May.

Second, we would require that as many programs as possible, certainly all of the major consumers of dollars and other resources, be identified on a mission or output oriented "program package" and "program element" basis.

• **Two key units**—By a "program element," we mean an integrated activity, a combination of men, equipment, and installations, whose effectiveness can be related to our national security policy objectives; as examples, we have in mind such forces as B-52 wings, infantry battalions, and combatant ships, taken together with all the equipment, men, installations, supplies, and support required to make them effective military forces.

By a "program package" we mean an interrelated group of program elements that must be considered together because they support each other or are close substitutes for each other. The Central War Defensive forces would be an example of such a package. The unifying principle of such packages is a common mission or set of purposes.

Total resource requirements for each of these program packages or elements would have to be identified, not only for FY 1963, but for 5 to 10 years into the future, depending upon the present phase and life of the program, and including not only RDT&E, procurement and installation costs, but also the costs of military personnel and operation and maintenance, and, where applicable, warhead costs.

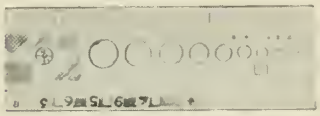
The Office of Programming has already undertaken the job of identification of program packages. We have a provisional list ready now. The degree of detail presented in it will have to be refined as the work progresses. In some cases it is inadequate while in other cases it may be excessive, or simply not broken down in quite the right way.

To continue the work of refinement, a program package team is being formed to consist of members of the Office of Programming, representatives from each military department, the JCS, the Office of Deputy Assistant Secretary (Budget), and Assistant Secretary of Defense (ISA). We will also take advantage of assistance from contractors who have studied and are knowledgeable in this sort of activity.

The tasks of the program package team will be several—first will be definition of specific contents of packages that have meaning from a planning and programming/financial management point of view. Second, the resource elements of the packages will be identified on as consistent a basis as possible.

NARROW-CHANNEL PHOTOGRAPHY

For people with the problem of photographing the interior of long, narrow channels, Kollmorgen has developed unusual devices capable of recording on film channels as narrow as 1/32 of an inch.



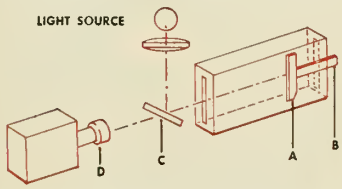
Above, actual size, is a test film of circles and numerals placed within a 1/32"-wide channel.



Above is a *panoramic* view of a continuous section of the same film . . . with marks enlarged 8x.



Pitting, corrosion, fracture and other defects of interior walls can be continuously recorded with full-dimensional accuracy . . . of exceptional value in quality control operations.



The secret of our insight: A highly precise 45° mirror (A), mounted on a reed (B), is inserted in one end of the channel. A beam splitter (C) directs a powerful light into the channel from the opposite end which is reflected by the mirror onto the sidewall. The photographic leg of the system receives the image from the channel mirror and through the beam splitter. A camera objective (D) focuses the image on the film. The channel is advanced by a carriage in precise synchronization with the advance of film. Result: a continuous, clear photographic record of the entire channel.

Various modifications of this device have been applied to channels up to six feet long. For longer and wider channels we have designed a miniature self-propelled camera, mirror and light source capable of presenting a continuous image on film with resolution sufficient to reveal scratches and hair-line cracks smaller than .010 inch.

If you need special insight on "inaccessible" interiors, or information on other unusual applications of optics/electronics/mechanics—let's talk it over.

Write Dept. 6-5

KOLLMORGEN CORPORATION
NORTHAMPTON, MASSACHUSETTS

Third, formats for clear and concise submittal purposes will be established, as well as formats and procedures for tentative approval of program packages by the Secretary of Defense and for updating approved packages. The ground rules regarding specification of military units, locations, activity rates, etc., will also be decided upon, and finally schedules for submittals by the military departments will be established.

The definition of a program element or package will involve both financial and non-financial factors; that is, a specification of both cost and capability. Costs will be expressed both in terms of expenditures and obligational authority. There is no thought at this time of abandoning the existing appropriation categories. Rather, our intention is to supplement them with program and cost information that is more meaningful for decision-making purposes.

• **Many questions**—We wish to define the program packages by the 1st of May, realizing of course that these will be preliminary definitions to be improved upon as we progress. The Programming Office will monitor the process of refinement of the package definitions.

Third, guidance will be provided on questions to be answered and studies and analyses to be performed in connection with the program review. Broadly speaking, we visualize four classes of questions, each to be answered by appropriate supporting analyses.

(1) First, there are questions regarding the forces themselves together with their associated weapons, equipment and installations. Do we want more, less, or the same amount of each type?

We must examine each force element in terms of both cost and effectiveness: costs in the sense of complete program costs, and effectiveness in the sense of military effectiveness in support of our Basic National Security Policy objectives. We must examine the costs and effectiveness of continuing existing forces unchanged, adding to them, or phasing them out.

These examinations must be made in the realization that more forces are always useful, but that the real questions are how useful, how important, and how effective, in comparison with alternative ways of achieving the same Basic National Security objectives within the total amount of resources available.

(2) Second, there are capital expenditure decisions to be made in connection with these forces. We want to look at each major item of equipment in relation to the force it is to equip, and to see how much is required for peacetime operation, and how much must be stockpiled for wartime readiness. We need to know all the costs and the implications of effectiveness of continuing to use existing equipment, modernizing, converting or rehabilitating it, or replacing it.

For example, in connection with each proposal for new ship construction, we need to consider the alternatives of:

(a) Continued operation of the existing ship;

(b) Modernizing or converting it;

(c) Replacing it with a new one or new ones of the same or different types; or,

(d) Phasing it out, along with its personnel and support, without replacement.

(3) Third, there are questions relating to activity rates and deployments. What activity and deployment factors affect the cost and effectiveness of the force? How do cost and effectiveness vary with, e.g., flying hours, maintenance schedules, exercises, alert status, crew ratios or manning levels, etc.? Which if any should be changed? Why? Can costs be reduced without commensurate reduction in effectiveness by variation in activity levels?

(4) Fourth, there are questions about management. Are our major forces organized efficiently? Do the supporting forces and activities bear an appropriate relationship to the combatant forces? Are the tables of organization right? Are the bases and installations in balance with the forces they support? Is the logistic guidance appropriate to our objectives?

• **Ike budget a benchmark**—Then there are special questions relating to research and development decisions. Here we want to examine each major weapon system program, as well as the basic and applied research program. In the case of weapon system developments, we want to know how effectively the system could contribute to which military objectives, the total development cost (in whatever appropriation account), and the future capital and operating costs if a decision were made to procure it.

In addition to general guidance on the supporting studies and analyses, there will be a more detailed list of questions and requirement studies associated with each program package review. This list will supplement the Secretary's list of 121 projects and include many items on it.

As program decisions are made, we will need some sort of benchmark to tell us where the decisions are leading us in terms of a total budget. We plan to use two controls. The first is the 1962 budget. For the second, we intend to ask the Services to cost out, in expenditures and NOA terms, the force structure submitted by the JCS in answer to Mr. McNamara's Project No. 3, that

(Continued on page 39)

Technical Countdown

ADVANCED MATERIALS

Beryllium Prices Drop Again

Virgin powder prices have been cut 12% by Brush Beryllium Co. A 15% slash in 20,000-lb. base-lot blended powder prices was announced by the firm because of the increased production capabilities at its Elmore, Ohio, plant. The facility will ultimately up Brush's output of pure beryllium to more than 30,000 lbs. a month.

Magnetic Resonance Provides Testing Tool

Nuclear magnetic resonance may be a critical tool in future non-destructive testing methods. Interpretation of Atomic-scale resonance measurements can supply information on lattice strain effects and solute concentration. Union Carbide physicists caution that extensive background in the field is a prime requirement, but they say the technique can be reduced to routine testing if properly developed.

TFE-Fluorocarbon Resins Standards

A standard establishing requirements and methods of test for three grades of TFE sheet in material, dimensions, physical and electrical properties has been submitted to industry by the Business and Defense Administration of the U.S. Commerce Dept. The standard, covering minimum thickness of 1/32 in., is the result of a request from the Society of the Plastics Industry.

SUPPORT EQUIPMENT

Space Surveillance Training Accelerated

The Air Force has stepped up its training program for operators of space surveillance facilities. A total of 28 officers and men are now taking an accelerated course at Hanscom Field to qualify them to operate SPADATS (space detection and tracking system) for NORAD. In addition to classwork in astronomy and satellites, the students are checked out by on-the-job training in satellite tracking at the AF Space Track facility.

Plasma Tunnel Being Completed

A plasma wind tunnel capable of sustained operation at speeds of Mach 3 and higher is scheduled for completion this month. The $350,000 tunnel, being built by North American Aviation, will be used for testing manned vehicles under re-entry conditions. The hypersonic gas flow is generated by a one-megawatt d-c arc which heats the plasma to temperatures in excess of 16,000°F.

PROPULSION

R-F Plasma Engine for Space

A plasma-propulsion space engine which uses UHF radio waves to accelerate charged particles has been demonstrated by RCA scientists. The device uses r-f power rather than magnets to produce the accelerating electrical field. Thrust can be increased by using higher frequencies to accelerate a denser plasma.

ELECTRONICS

Transistor Sales Up

February transistor sales gained one million units over the previous month, EIA reports. Sales for the first two months of 1961 were up a total of over 6 million units over the same period last year. Dollar volume was down almost $1 million, however, reflecting steadily decreasing unit costs.

Micromodule Development in Second Phase

P. R. Mallory, Indianapolis, Ind. and Paktron, Alexandria, Va., have been selected by the Army Signal Corps to develop alternative methods for assembling micromodule circuits on a production basis. Phase One of the program, carried out by RCA and some 50 other manufacturers over the past three years, established the feasibility of the micromodule concept.

Missile Fabrication Patent Awarded

Convair/Pomona has just received a patent for its technique of manufacturing missiles by means of wheel-shaped subassemblies. The patent covers a design employing circular cross-sectional slabs of electronic circuitry. These are joined longitudinally by four tension bolts extending through all of the sections to be assembled. The concept reportedly reduces the size and weight of missile structures by a ratio of 6:1.

ENERGY CONVERSION

Another Bacterial Fuel Cell Announced

Generation of electricity by the chemical reaction of living organisms (bacteria) has been successfully demonstrated by a second researcher. Joseph Kaye & Co., Cambridge, Mass., developers of the new "bug battery," say that chemical reaction rates obtained with bacteria are as much as a million times faster than those of conventional chemical reactions. Fuels for such a cell are common and practically unlimited—sewage is one example. Announcement of the success came soon after disclosure (M/R, April 17, p. 18) of a similar development by Dr. Frederick D. Sisler of the Interior Department.

Lampre I Begins Operation

The world's first molten-plutonium experimental nuclear reactor, *Lampre I*, has achieved a self-sustained controlled chain reaction at operating temperature at Los Alamos Scientific Laboratory. *Lampre I* will help evaluate the idea of using metallic plutonium as a fuel in liquid form. Low melting points may thus be changed from a disadvantage to an advantage.

OPTICS

Fiber Optics to be Lasered

First application of fiber optics to lasery may be made by American Optical Company's research center in Southbridge, Mass. Its scientists have several projects under way for the employment of very-fine-diameter clad fibers in the laser geometry. AO believes these will permit highly precise mode selection and mode coupling and thus significantly lower power requirements. (See report on page 33.)

Exclusive: Titan Gets Ablative Skirt

by Frank G. McGuire

AZUSA, CALIF.—An ablative skirt adopted for the second-stage engine of both *Titan* versions will allow a "dry start" ignition expected to greatly increase reliability.

Aerojet-General Corp., developer and producer of all *Titan* engines, says the new skirt will make it possible to ignite the engine without the presence of fuel in the regeneration-cooling tubes of the chamber wall, and the possibility of leakage causing an explosion.

Fuel and oxidizer will be sealed off behind flow control valves until ignition has been achieved in the combustion chamber, at which time the fuel will be introduced to regeneratively cool the chamber.

In *Titan II*, the ablative skirt takes up almost all the expansion chamber, from 13:1 to the full 45:1 ratio areas.

Fabrication of the chamber skirt is begun by shingle-wrapping a pre-impregnated asbestos tape at a 45° angle to the surface of a rotating mandrel. The tape, containing the phenolic resin, is then covered with hair felt and glass contour tape so that volitiles generated during curing may escape.

A vacuum bag is placed over the entire assembly to maintain a vacuum or 22 to 30 in. Hg during the curing operation up to temperatures of 330°F. During this cure, the vacuum-bag-wrapped mandrel is in an autoclave maintained at 185 to 250 psig.

After cure, the liner is machined to proper dimensions while still on the mandrel; then reinforcement in the form of glass cloth is applied to the outside surface. The glass cloth, like the original asbestos tape, is pre-impregnated with phenolic resin

● **Bonding and reinforcing**—At this point, the attachment flange for mating with the combustion chamber is applied, using aluminum alloy 6061-T6. The segments of this flange are bonded to the forward edge of the liner with a liquid adhesive.

This bond is reinforced with asbestos-reinforced phenolic tape and phenolic-resin-impregnated glass cloth applied over the flange segments and the entire length of the skirt liner. Curing is then conducted for one hour at 320°F.

Another reinforcing factor is then laid on by application of a cellular fibreglass core, held in place by a film of adhesive. Pre-cut sections of fiberglass core are put in place, the entire skirt being again cured at 300°F for one hour, after which the core is trimmed and shaped.

An epoxy filleting compound, cured by heat lamps, is applied to the aft edge of the skirt to act as reinforcing. This compound is wrapped with glass tooling tape.

Final outer wall of the skirt is formed of phenolic-resin-impregnated glass cloth cemented to the cellular core in segments. Epoxy-resin-impregnated glass roving is wrapped over the flange area.

Final curing is for two hours at temperatures between 220° to 280°F.

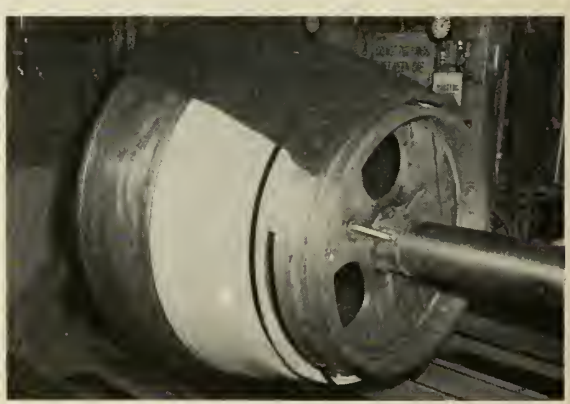
Approximately 14% by weight of the asbestos is water, released between 1200° and 1400°F. At about 1490°F, the asbestos changes phase, and subsequently melts at around 2800°F. ⌗



1 *Mandrel of 6061-T6 aluminum with surface finish of 65 to 125 RMS used for wrapping ablative liner for Titan skirt.*

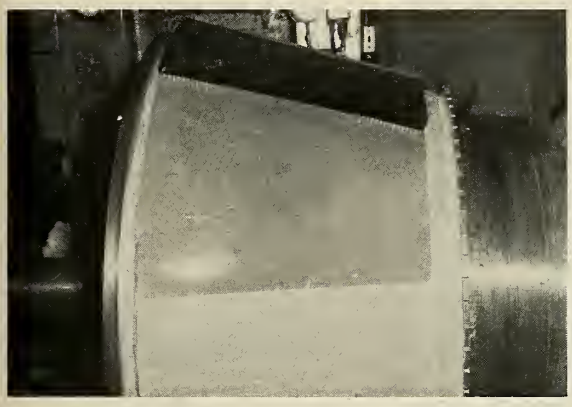


2 *Shingle wrapping of asbestos tape, pre-impregnated with phenolic resin, on the aluminum mandrel.*

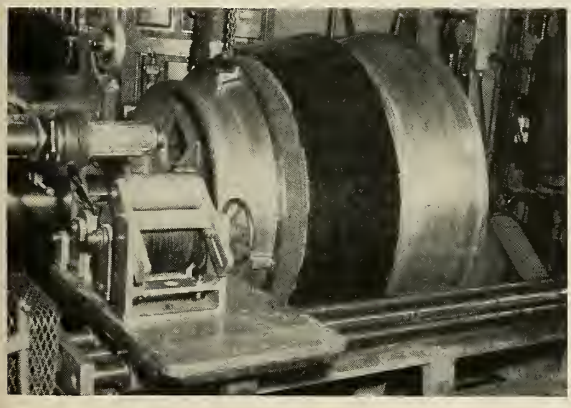


3 *Glass contour tape and hair felt, to permit escape of volatiles during cure, are applied over asbestos lay up.*

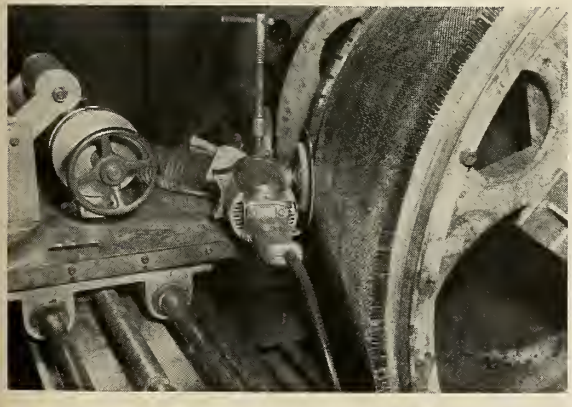
ɔn 2nd Stage



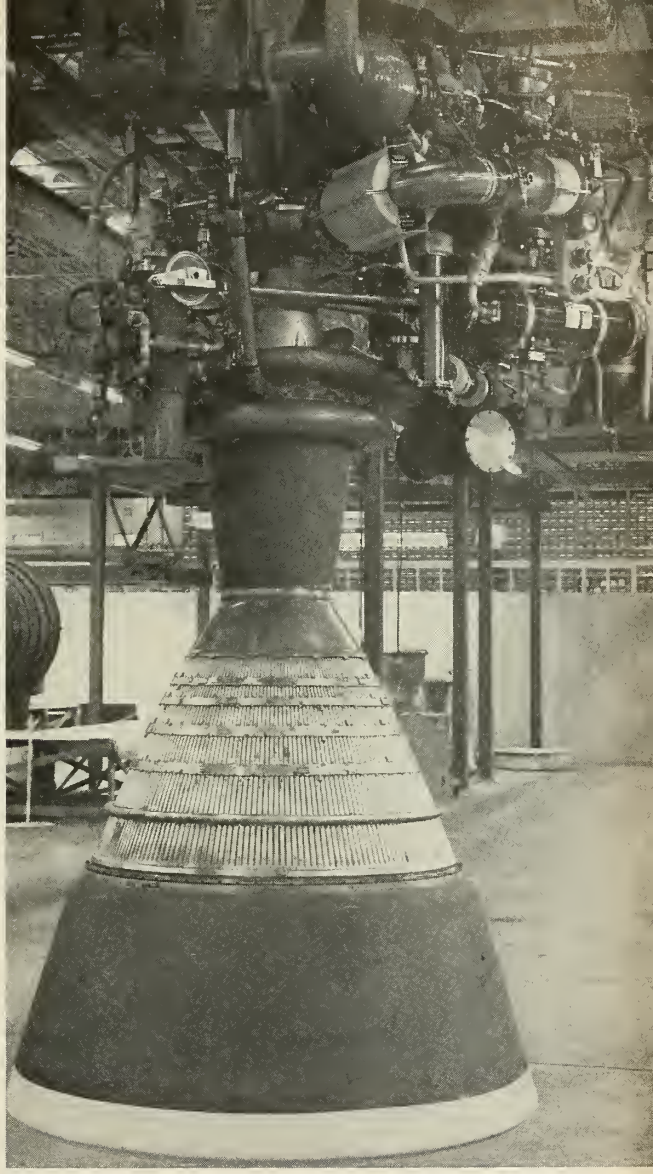
4 *After even cure, liner is machined, supported film adhesive applied to liner, fiberglas applied to adhesive.*



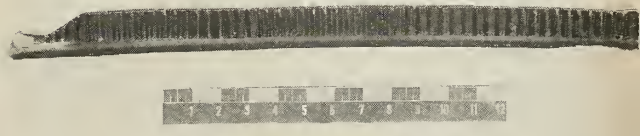
5 *Cellular fiberglas segments shown in place on skirt and ready for curing.*



6 *After cure, the cellular fiberglas reinforcement is machined to proper dimensions.*



7 *Completed ablative skirt for Titan's second-stage engine. Earlier models had chambers of hollow steel tubes.*



8 *Cross-section of the ablative skirt after a full-duration firing. Note char depth of the ablative liner.*

IBM Dedicates Giant Research Center

Watson facility, believed to be world's largest for data processing R&D, to be used as 'international clearing house'



NEW CRESCENT-SHAPED Thomas J. Watson Research Center was formally dedicated last week. The world's largest facility for computer research, its expandable structure now provides nearly 3 million sq. ft. of floor space for 1500 International Business Machine Corp. personnel.

YORKTOWN HEIGHTS, N.Y.—International Business Machines Corp. has opened what is believed to be the world's biggest research complex devoted to advancing data processing technology.

The vast Thomas J. Watson Research Center, dedicated here last week, is also a striking demonstration of the growing emphasis on R&D and the trend toward manpower consolidation by major manufacturers. Some 700 top scientists, engineers and technicians—plus a 300-member support staff—have been assembled from many of IBM's laboratories around the world.

A press review served as a rehearsal for the formal opening of the Center at the corporation's annual stockholders' meeting last Tuesday. (A circus tent was erected at the rear of the Center to accommodate 3000 stockholders.)

The three-story, five-block-long building is the epitome of modern functional architecture. Throughout, it is designed for maximum well-being of its occupants; even its location, in quiet, rolling upper Westchester County, is inducive to relaxed concentration.

In the Center's work, it is expected that all of the classical scientific disciplines will be represented. An IBM spokesman indicated that about 25% of the studies performed will be in pure research. The applied research and development effort will, of course, be directed to the general field of information processing.

But, it was stressed, the Center will employ a freer approach to R&D than that found in IBM's separate operating-division laboratories.

Central areas of interest at the Center, said IBM, will be solid-state physics, chemistry, and mathematics. Because of current trends in computer technology, the disciplines of biophysics, information retrieval, and linguistics will be heavily stressed.

IBM will use the facility as an "international clearing house for new thinking in computer science." Other principal research laboratories for IBM will remain at Columbia University in New York, San Jose, Calif., and Zurich, Switzerland.

• **Organization**—Six broad exploratory fields or divisions comprise the organization of the new facility:

—General Science for the present will stress studies in lasers, magnetics, cryogenics, and semiconductor phenomena—particularly ferrites.

—Solid State Science will probe for new materials and for new processes and controls for obtaining such materials in useful form. Much of its work will be in the study of low-temperature, thin-film deposition instead of the more conventional high-temperature cracking processes used widely in industry.

—Experimental Systems are concentrating on the machine translation of languages, and on new systems for information retrieval for control of industrial processes.

—Experimental Machines will deal primarily with advanced concepts for super-speed computers.

—Engineering Science is concerned with studying pattern-recognition (aural and graphic) systems. Much of the work has centered on the study of acoustics and vowel recognition by tape editors. Such work may someday permit verbal commands to automatic industrial control systems or even automatic printout of human dictation, said one of its scientists.

—Mathematical Sciences will investigate new logical approaches to computer design. It will also study the whole gamut of computing and operating problems.

• **Painstaking design**—The structure, designed by Finnish-borne Eero Saarinen, embodies an unusual architectural form for such a facility. The building is crescent-shaped and almost completely enveloped in glass.

Primary interior and exterior walls are finished with rugged field stone.

All laboratories and offices are windowless, opening into short radial aisles. This approach was the result of a long study of scientist and engineer work habits by Saarinen. Office appointments and colors were selected according to the majority preference of the users.

Total floorspace for the structure is almost 3 million square feet. Most nonstructural walls within the building are movable, permitting great flexibility in changing floor space arrangement.

The curved structure eventually will accommodate some 1500 occupants and can be expanded readily at any time. ⌗






MISSILES and ROCKETS

ASTROLOG

Current status of U. S. missile and space programs plus all orbiting satellites



Satellites and Spacecraft

PROJECT	CONTRACTORS	DESCRIPTION	STATUS
★**ADVENT** (Army)	Army Signal Corps, prime; Bendix prime for 24-hour satellite communicotions package; GE, vehicle	Twenty-four hour instontaneous repeoter communicatians satellite; 1000 lbs.; program incorporotes Projects STEER, DECREE ond COURIER	R&D; ground sites to be equipped ot Ft. Dix, N.J., and Camp Roberts, Calif.; shipboord terminals olso being designed; first ATLAS-CENTAUR launchings lote '62
ANNA (Army, Novy, AF, NASA)	No cantroctars announced	Geodetic sotellite; 50-100 lbs.; probably sphericol	Study completed; R&D pragrom appears imminent
★**AEROS** (NASA)	No contract announced	24-hour weother sotellite to be boosted by CENTAUR	Planning. First flights wauld be in 1964 or 1965; unfunded FY '62 budget; TV comero R&D ta begin soon
★**APOLLO** (NASA)	Convair, Martin, GE	Three-man spacecraft capoble of orbiting moon or becoming spoce stotion; probobly winged for lunor flights; boosted by SATURN	Six-month studies due in May; first orbitol stotion tentotively scheduled obout 1967; R&D contract possibly to be let in FY '62; plons delayed
ARENTS (ARPA)	Convair, prime	Satellites to investigote deep spoce; 22,000 m. orbits; ATLAS-CENTAUR boaster	Contract let to build three payloads, lounchings begin early '62
ASP (Air Force)	No contracts onnounced	Aerospoce plone, o monned spacecroft capoble of operoting in the otmasphere ond spoce	Study
★**BAMBI** (ARPA)	Convair, STL	Sotellite system copoble of intercepting enemy missiles in boost phase	Studies
CSAR (Air Force)	Na contracts onnounced	Communications sotellite system; sotellites ta weigh possibly two tons; to use passive lens reflectors	Studies; possibly aperotional mid-60's
★**DISCOVERER** (Air Force)	Lockheed, prime; GE, re-entry vehicle	THOR-AGENA and ATLAS-AGENA launchings af early stobilized satellites; moin purpose is to test techniques for militory spoce systems	Launchings: 23; 5 capsules recovered from orbit (3 air-snotched); after orbiting eorth one to three doys; plons ta put simions in copsules deloyed
★**DYNA-SOAR I** (Air Force)	Boeing, spacecroft ond systems integrotor; Martin, propulsian; Minneapolis-Honeywell, guidonce; RCA, communications doto link	Boost-glide orbitol spocecraft; R&D leading to first spoce bomber; TITAN II booster; 3rd powered stoge to be odded	R&D; first glider flights from Edwards AFB by 1962; R&D space flight obout 1966; progrom accelerated somewhat under FY '62 budget
★**ECHO** (NASA)	Longley Research Center, prime	ECHO I: 100 ft. inflotoble sphere in 1000 mile orbit; passive cammunicotion sotellite; ECHO II: 135-ft., 700-mi. orbit	In orbit since Aug. 12, 1960; ECHO II scheduled to be launched 1962; suborbital tests lote '61

★ Indicates change since March 1961 Astrolog

PROJECT	CONTRACTORS	DESCRIPTION	STATUS
MARINER (NASA)	JPL, prime	600-1200 lb. unmonned spocecraft for early interplanetory missions; boosted by ATLAS-AGENA B	Seven shots planned. First scheduled Venus fly-by Aug. 1962
★**MERCURY** (NASA)	McDonnell, capsule	First U.S. monned sotellite; 2500 ib. capsule; ATLAS boosted	First monned orbit shot expected late 1961 or early 1962. Attempt to orbit unmonned capsule April 25 foiled becouse of booster molfunction
★**MIDAS** (Air Force)	Lockheed, prime; Aerojet, IR detectar system	Eorly-warning satellite; detect ICBM launchings by infrared before birds leove pad; R&D models weigh 2.5 tons; operational system to have 12-15 sotellites	R&D; second launching May 24 portiol success; components being tested by DISCOVERER
★**NIMBUS** (NASA)	GE, prime	2nd generation weother satellite; 650 lbs.; 6 TV comeros in payload; THOR-AGENA B booster	First launching scheduled for late 1962
★**OAO** (NASA)	Grumman, prime; Westinghouse, electronic components; GE, stabilizotian and control	3500-lb. orbiting ostronomicol sotellite observatory equipped with telescope; boosted by ATLAS-AGENA B	First flight scheduled in late 1963 or 1964
OGO (NASA)	Space Technalogy Laboratories, prime	1000-lb. satellites with instruments for geophysical measurements; polor (POGO) and eccentric (EGO) shots planned; ATLAS-AGENA B, THOR-AGENA B, CENTAUR boosters	First flight scheduled in 1963
OSO (NASA)	Ball Brothers, prime	350-lb. orbiting salar observatory; THOR-DELTA baoster	First flight p'onned summer 1961
PROSPECTOR (NASA)	No contract onnounced	Soft-landed, remote control, unmanned moon exploring spacecroft; SATURN booster	First flight planned by 1965; study contracts ta be owarded in 1961
RANGER (NASA)	JPL, prime; Aeronutronic, capsule; Hercules, retrorocket	300-lb. instrumented capsule rough landed on moon; ATLAS-AGENA B booster	R&D; first flight plonned 1961; first lunor landing planned for 1962, instrumentation to include seismometer.
★**REBOUND** (NASA)	No contract announced	System of 3 to 6 multi-launched ECHO II communications sotellites	First orbital flight scheduled for 1963 or 1964
★**RELAY** (NASA)	No contracts onnounced	85-lb. active repeoter communicotions satellites. Commercial system plonned; DELTA ond AGENA B launched	Contract ta be awarded soon
SAINT (Air Force)	RCA, prime	Anti-satellite sotellite inspection system; to be complemented by interception system; about 2 tons; ATLAS lounched	R&D underway; to be launched ogoinst reflectors or balloons in 400-mi. orbits late '61
SAMOS (Air Force)	Lockheed, prime	Reconnaissonce sotellite; formerly SENTRY; R&D model weighs 4100 lbs.	R&D; SAMOS II successfully launched Jon. 31 from Vandenberg. First lounch failed to put SAMOS in orbit Oct. 11; scheduled to be operational late 1962, early 1963 under new, bigger program; components being tested in DISCOVERERS
SLOMAR (Air Force)	Lockheed ond Martin, prime	Logistics, maintenance, supply spacecraft for space systems	Study contracts awarded in December
★**SURVEYOR** (NASA)	Hughes, prime	750-lb. spocecroft soft-londing 100-300 lbs. instruments on moon; ATLAS-CENTAUR booster	First moon flights 1963; seven to be lounched by 1965
TIROS (NASA-AF-Army-Navy-Wea. Bu.)	RCA-Army Signol Corps, prime	Meteorological satellite; TV pictures of cloud cover; TIROS II corried IR scanner	R&D; first lounching lost April; second Nov. 23, both successful. At leost one more planned
★**TRANSIT** (Navy)	Applied Physics Laboratory, prime	Navigotionol sotellite; R&D model weighs more thon 250 lbs.; operational model obout 50-100 lbs.	TRANSIT IB R&D sotellite in orbit April 13; IIA plus piggyback sotellite in orbit June 22; TRANSIT IIIB launched into poor orbit Feb. 21; four-sotellite system scheduled to be in orbit 1962
VOYAGER (NASA)	No contract announced	Unmanned spacecraft to orbit Mars or Venus; eject capsule for re-entry; SATURN booster	Study; first flight plonned by 1965
YO YO (Navy)	No contract announced	Tactical seo-launched one-poss reconnoissance satelloid	R&D
★**X-15** (NASA-AF-Novy)	North American, prime; Thiokol, propulsion	Rocket plone; 4000 mph; flight ot edge of spoce; on AF model each XLR-11 rocket engine develops 16,000 lbs. of thrust; XLR-99 engines 50,000 lbs. Three plones delivered.	Powered flights in progress; plane #1 hos hit Moch 3 ond more thon 136,500 ft. with XLR-11 engine; plane #2 with XLR-99 engine turned over to NASA; has hit 3074 mph speed record; altitude record of 169,600 ft. (unofficial for monned, powered flight)



Missiles and Rockets

PROJECT	CONTRACTORS	DESCRIPTION	STATUS
ALFA (Navy)	Navy, prime; Avco, air frame	ASW surface-to-underwater; 500 lb. solid; conventional	Deployed on destroyer escorts
ARM (Air Force)	No contract announced	Anti-radar missile; air to surface	Studies; plan for separate missile shelved at least temporarily
ASROC (Navy)	Minneapolis-Honeywell, prime; Sangamo Electric, sonar; torpedo, GE; depth charge, M-H	Surface-to-underwater; solid rocket torpedo or depth charge; nuclear or conventional, range about 8 miles; advanced ASROC (improved Mark 44 torpedo) under R&D	R&D; operational on Destroyers Norfolk, Adams, Dewey and Perry; plans call for deploying on 150 destroyers and cruisers
ASTOR (Navy)	Westinghouse, prime	ASW underwater to underwater rocket torpedo; nuclear	R&D
★**ATLAS** (Air Force)	Convair, prime; GE/Burroughs, Arma, guidance; Rocketdyne, propulsion; GE/Avco, re-entry vehicle	ICBM; more than 5500-to-7500 mile range; liquid; nuclear; ATLAS "E" series has inertial guidance; earlier ATLAS "D" has radio inertial; proposed ATLAS "G" would have 900,000-lb. thrust and 4000-lb. payload capability	82 launchings; 53 successes, 20 partial, 9 failures; 11 bases for 13 squadrons; operational at Vandenberg and Warren; ATLAS E tests began Oct. 11; about 18 to 21 launchers operational—40 to 60 expected in 1961. First successful "E" shot Feb. 24
★**BOMARC-A** (Air Force)	Boeing, prime; IBM/Westinghouse, guidance; Aerojet/Marquardt, propulsion	Ramjet surface-to-air interceptor; liquid booster; 250 m. range; Mach 2.7; nuclear	Five bases operational in Northeastern U.S. from Virginia to Maine
★**BOMARC-B** (Air Force)	Boeing, prime; Kearfott/Westinghouse, IBM Guidance; Thiokol/Marquardt, propulsion	Ramjet, surface-to-air; solid booster; Mach 2.7; more than 400 m. range; nuclear	B models being produced; a B test bird intercepted simulated target 345 miles away Oct. 14; to be deployed at 6 U.S. bases, two in Canada
★**BULLPUP** (Navy-Air Force)	Martin, prime; Martin, guidance; Thiokol, Naval Propellant Plant, propulsion; Maxson, second-source prime	Air-to-surface; 3-6 mile range; conventional 250-1000-lb. bomb; new model has pre-packaged liquid; nuclear-tipped model nearly operational; AF designation: GAM 83-A (HE warhead), GAM 83-B (nuclear)	Deployed with Atlantic and Pacific Fleets; bigger model under R&D; soon operational with Air Force units. Marines launching BULLPUP from helicopters
COBRA (Navy)	No contract announced	Anti-ship radar missile	Early R&D
COBRA (Marines)	Boelkow Entwicklungen, West Germany, prime manufacturer; Doystram, U.S. licensee	20.2-pound anti-tank missile; 1 mile range; 191 mph speed; solid propellant	Marines planning to purchase; Army considering them; already operational with West German troops
CORPORAL (Army)	Firestone, prime; Gilfillan, guidance; Ryan, propulsion	Surface-to-surface; 75-mile range; liquid; nuclear	Deployed with U.S. & NATO troops in Europe
CROW (Navy)	No contract announced	Air-to-air missile	R&D; has been flight tested
DAVY CROCKETT (Army)	In-house project directed by Rock Island, Ill., arsenal	Surface-to-surface; solid; bazooka launched; sub-kiloton nuclear warhead; two launchers of different size for various ranges; vehicle mounted or carried by two men	R&D; operational this year; first NATO deliveries also this year
★**EAGLE** (Navy)	Bendix, prime; Bendix, guidance; Aerojet, propulsion; Grumman, airframe	Air-to-air; 100-mile range; nuclear; for launching from relatively-slow Douglas Missileers now under development; EAGLE is 15 ft. long; wt., about 2000 lbs.; Mach 4; solid	Program cancelled
★**ENTAC** (Army)	Nord Aviation, prime	Anti-tank; 6600-ft. range; 37 lbs.; HE warhead; wire-guided	Operational; Army buying from French in quantity
FABMIDS (Army)	Convair, Hughes, Martin, GE, Raythean, Sylvania—feasibility studies	Mobile anti-missile defense system	Each of six contractors have $250,000 feasibility study contracts awarded Oct. 10; reports expected mid-'61
★**FALCON** (Air Force)	Hughes, prime; Hughes, guidance; Thiokol, propulsion.	Air-to-air; 5-mile range; Mach 2; solid; conventional; GAR-11 has nuclear warhead	GAR-1 through GAR-4 operational; GAR-9 R&D; GAR-11 operational in near future; buy-out of GAR 3A, 4A and 11 in FY '62
GENIE (Air Force)	Douglas, prime; Aerojet-General, propulsion	Air-to-air unguided; 1.5-mile range; nuclear	Operational
GIMLET (Navy)	No contract announced	Air-to-surface; unguided; considered highly accurate	R&D

PROJECT	CONTRACTORS	DESCRIPTION	STATUS
HAWK (Army)	Raytheon, prime; Raytheon, guidonce; Aerojet-General, propulsion	Surface-to-oir; 22-mile range; solid; conventionol; designed to hit low-flying plones	Operational; deployed ot Ponoma, Okinawa; SUPER HAWK under develoopment; Jan. 29, 1960 successfully intercepted HONEST JOHN, first known missile intercept of another
HONEST JOHN (Army	Douglas/Emerson Electric, prime; Hercules, propulsion	Surface-to-surfoce; unguided; 12-mile range; nucleor	Operotionol; deployed in Europe
HOUND DOG (Air Force)	North Americon, prime; Autonetics, guidance; Pratt ond Whitney, propulsion	Air breathing air-to-surfoce; 500-mile range; Moch 1.7; turbojet; nuclear	Operotional; to be lounched from B-52G intercontinentol bombers; stockpile expected to exceed 400
★**JOSHUA** (Air Force)	No primes announced	Lightweight ICBM nucleor	Study; some hordware
JUPITER (Army)	Chrysler, prime; Ford Instrument, guidonce; Rocketdyne, propulsion; Goodyear/CTL, re-entry vehicle	IRBM; liquid; nuclear; can be made mobile	To be deployed with Italion and Turkish troops. 31 militory launchings: 24 successes; 5 portiols; 2 failures. Full tactical GSE used for first time in Oct. 20 shot from Cope
LACROSSE (Army)	Martin, prime; Martin, guidance; Thiokol, propulsion	Surface-to-surface; highly mobile; 20-mile range; solid; nucleor	Operotionol; three units deployed in Europe; more being troined; odvonced LACROSSE R&D dropped
LAW (Army)	Hesse-Eastern Div., Flightex Fabrics, prime	Light onti-tonk rocket; corrier tube launcher; 4.5 lbs.; 25 in. long/3 in. diameter	R&D under AOMC
LITTLE JOHN (Army)	Emerson Electric, prime; Hercules Powder, propulsion	Surfoce-to-surface; unguided; 10-mile ronge; solid; nucleor	First 4-launcher battalion operotional this winter
LOBBER (Army)	No contract onnounced	Surfoce-to-surfoce; cargo carrier; 10-15 mile range; also can drop nopolm; LOBBER with warhead called BALLISTA	Studies
LULU (Navy)	Generol Mills/Naval Ordnance Lab, prime	Small nucleor depth charge oir-dropped or lounched by ASROC	Operational
MACE (Air Force)	Martin, prime; Goodyeor/AC Spark Plug, guidance; Thiokol/Allison, propulsion	Air-breothing surface-to-surfoce; more than 650-mile range; turbojet & solid; nucleor; B model hos more than 1200 m. ronge	Being deployed with U.S. troops in West Germany; now oll mobile but hard-base version in R&D; to be in Okinowo, Koreo
MATADOR (Air Force)	Mortin, prime; Thiokol/Allisen, propulsion	Air-breothing surface-to-surfoce; 650-mile range	Being turned over to West Germans; olso deployed in Far East
MAULER (Army)	Convair, prime	Surface-to-oir; rodor guidonce; highly mobile ontioircroft ond antimissile missile for field use; on tracked vehicle; 12 missiles per launcher	R&D; NATO may buy
★**MINUTEMAN** (Air Force)	Boeing, major contractor; Autonetics, guidance; Thiokol, propulsion first stage; Aerojet, propulsion second stage; Hercules, third stage; Avco, reentry vehicle; AMF-ACF, rail louncher	2nd generation ICBM; solid; fixed or mobile aboard roilroad trains; nuclear; 3 stages	R&D; scheduled to be operotional mid-1962 at Malmstrom AFB; first R&D flight (oll stages igniting) from Cape Feb. 1 o success; toctical rail system tests completed; 3 squadrons ot Malstrom; 3 ot Ellsworth AFB, S.D.; 12 fixed squadrons now plonned; mobile system indefinitely postponed
M-55 (Army)	Norris Thermador, prime	Four-inch diometer, small, short-range poison gas rockets; to be fired from 45-tube launchers	Operotional
MISSILE A (Army)	ARGMA, prime	Surface-to-surfoce; 10-20 mile range; solid	Design studies
NIKE-AJAX (Army)	Western Electric, prime; Western Electric, guidance; Thiokal, propulsion; Douglos, airframe	Surfoce-to-oir; 25-mile ronge; Moch 2.5; solid & liquid; conventional	Deployed in U.S., Europe & For East; obout 170 batteries in U.S., sixty-eight more to be phased out and reploced with NIKE-HERCULES
NIKE-HERCULES (Army)	Western Electric, prime; Western Electric, guidance; Hercules & Thiokal, propulsion; Douglas, airframe	Surface-to-air; 75-mile ronge; Mach 3+; nuclear; anti-oircraft, tacticol mis-iles; mobile or fixed	Rapidly replocing NIKE-AJAX; well over 80 batteries deployed in U.S.; more thon 10 N-H botteries being deployed overseas in 1961; N-H on Formosa
★**NIKE-ZEUS** (Army)	Western Electric, prime; Bell Telephone, guidance; Thiokol/Grond Centrol, propulsion; Douglas, airframe	Anti-missile; 3-stage; 200-mile ronge; solid; nuclear	R&D test launchings ot White Sonds, 14 R&D launchings; 8 successful, 4 portial, 2 foilures. Complete system tests now scheduled for early '62
★**PERSHING** (Army)	Martin, prime; Bendix, guidance, Thiokol, propulsion	Surfoce-to-surface; two-stage solid; opprox. 500-mile range; nuclear; transported on FMC XM474 trocked vehicle; proposed PERSHING II would hove 1000-mile range	R&D; to replace REDSTONE; 15 R&D launchings: 13 successes (both stoges lounched, guidonce carried os possenger Dec. 12 for first time), 2 foilures. Operotionol late 1961; R&D launching obout 250 miles April 21

PROJECT	CONTRACTORS	DESCRIPTION	STATUS
★**POLARIS** (Novy)	Lockheed, prime; GE/MIT, guidance and fire cantral; Aerojet-Generol, propulsion; Lockheed, re-entry vehicle	Underwater and surface-ta-surface; solid; 1200-mile ronge con hit mare than 90% all torgets in Russia; nuclear; POLARIS II (1500-mile ronge) and SUPER POLARIS (2500 mile range) under R&D	94 launchings of test vehicles; 62 successes; 21 portial; 5 failures; 20 also launched fram submerged subs—all cleared surface; 12 successful flights, 8 failures. Two subs each with 16 missiles operational, 3rd deploying this spring. Totol outhorized by White Hause: 29. POLARISES for cruiser Long Beach cancelled; Poloris II R&D missiles impacting 1400+ n.mi. in guided flight
QUAIL (Air Force)	McDonnell, prime; Summers Gyro, guidance; GE, propulsion; Ramo-Wooldridge, ECM equipment	ECM-corrying bomber decay; about 200 m. ronge; jet powered	Deployed at SAC bases; corried by B-52
RAVEN (Novy)	No cantract onnounced	Air-ta-surfoce; obout 500-mile range	Study
REDEYE (Army)	Canvair, prime; Philco/Canvair Atlantic Reseorch, propulsion	Surfoce-to-air; 4-foot, 20-lb. bazooka-type; IR guidance; salid; conventional; container-louncher disposoble	R&D; Morines olso will use; NATO may buy
REDSTONE (Army)	Chrysler, prime; Ford Instrument, guidance; Rocketdyne, propulsion	Surface-to-surface; liquid; 200-mile range; nuclear	Deployed with U.S. troops in Europe; to be replaced by PERSHING
REGULUS I (Novy)	Chonce Vaught, prime ond guidonce; Aerojet-Generol, propulsian	Surfoce-to-surface; turbojet & solid; 500-mile range; nuclear	Deployed oboard U.S. submorines; REGULUS II used as torget drone
SEMPER (Morines)	No cant acts announced	Believed to be an air-launched missile	R&D testing at Pt. Mugu
SERGEANT (Army)	Sperry, prime; Sperry, guidance; Thiakol, propulsion	Surfoce-to-surfoce; solid; more than 75-mile range; nuclear	In production
SHILLELAGH (Army)	Aeronutronic, prime	Surface-to-surfoce; lightweight; can be vehicle-mounted	Early R&D
SIDEWINDER (Novy-Air Force)	GE-Philca, prime; Philca/GE guidance; Noval Powder Plant, prapulsian	Air-to-oir; IR guidance; more thon 2 m. ronge; conventional; new I-C models to hove switchoble IR ond rodor-guided warheads	Deployed with Navy and Air Force; all-weother type under development
★**SKYBOLT** (Air Farce)	Douglos, prime; Nortranics, guidonce; Aerojet, propulsion; GE, re-entry vehicle	ALBM; more than 1000-mile ronge; solid; nucleor; to be launched from B-52, B-70 ond Vulcan bombers	R&D; to be purchosed by British; operational 1964; test-launching to be from Eglin AFB, Fla. Add. funding restores old operotionol date
SLAM (Air Force)	No contract announced	Surfoce-to-surface; low-altitude; supersanic; nuclear ramjet and warhead	Study-R&D
★**SNARK** (Air Force)	Norair, prime; Northrop, guidonce; Pratt & Whitney/ABL, propulsion	Surface-to-surfoce; 5500-mile ronge; solid and turbojet; Moch .9; nucleor	One squadran of about 20 missiles at Presque Isle, Maine; to be eliminoted
SPARROW III (Navy)	Roytheon, prime; Roytheon, guidonce; Aerojet-Generol, Thiokal, propulsion	Air-to-air; 5-8 mile range; Moch 2.5-3; solid ond pre-packoged liquid; conventional	Operotional with corrier aircraft eorlier SPARROW I absolete; new cantract extending range, altitude
SUBROC (Navy)	Goodyeor, prime; Kearfott, guidonce; Thiokal, propulsion	Underwoter or surfoce-to-underwoter; 25-30 mile range; solid; nuclear	Estimoted aperotianol date: 1961. To be installed first on Thresher nuclear-powered attock submarine
SS-10 (Army)	Nord Aviotian, prime; GE, U.S. licensee	Surfoce-to-surfoce; primorily antitonk; 1600-yards ronge; 33 lbs. solid; wire guided; conventional	Operotional with U.S., French and other NATO and Western units; battle-tested in North Africa
SS-11 (Army)	Nord Aviotian, prime; G.E., U.S. licensee	Surfoce-to-surface; alsa helicopter-to-surface; 3800-yord ronge; 63 lbs; wire guided; conventianol	Operational. Under evaluation by Army; decision on procurement due for some time
TALOS (Novy)	Bendix, prime; Bendix/Sperry, guidance; Noval Propellont Plant, prapulsion	Surfoce-to-surface; 65-mile ronge; solid & romjet; Moch 2.5; nuclear	Operotionol oboard cruiser Galveston
TARTAR (Novy)	Convair, prime; Raytheon, guidance; Aerojet-Generol, prapulsion	Surface-to-air; 10-mile ronge; Moch 2; 15 feet lang & 1 foot in diameter; solid duol-thrust motar; conventional	Operational an Missile Destroyer Adams in Oct.
TERNE (Navy)	Kongsberg Vapenfobrikk, prime; Arma, systems integrotion	Surface-to-underwater ASW missile; 264 lbs; HE worhead	Navy buying fram Narway to equip two destrayer escorts
TERRIER (Navy)	Canvoir, prime; Reeves/FTL, Sperry guidance; ABL, propulsion	Surface-to-air; 10-mile ronge; Moch 2.5; 27 feet long; solid conventionol	Operotionol with fleet
★**TERRIER-ADVANCED** (Navy)	Canvoir, prime; Reeves/FTL, Sperry guidonce; ABL, propulsion	About 100% performance improvement over TERRIER	Operationol with fleet; being deployed on destroyers and carriers
★**THOR** (Air Force)	Douglas, prime; AC Spark Plug, guidonce; Racketdyne, prapulsian; GE re-entry vehicle	Surfoce-to-surface IRBM; 1500-mile range; liquid; nuclear	Operationol; 4 bases set up in Englond. 66 military lounchings: 45 successes; 11 partial; 10 failures. 48 scientific launchings: 40 successful, 2 portiol; 6 failures

PROJECT	CONTRACTORS	DESCRIPTION	STATUS
★**TITAN** (Air Force)	Martin, prime; Bell/Sperry, TITAN I guidance; AC Spark Plug, TITAN II guidance; Aerojet-General, propulsion; Avco, TITAN I re-entry vehicle; GE, TITAN II re-entry vehicle	Surface-to-surface ICBM; 5500-mile range; liquid; 90 feet long; nuclear; TITAN I burns LOX-Kerosene; TITAN II has storable propellants, inertial guidance, bigger payload, greater range, 115 ft. long TITAN III proposed	32 launchings test vehicles: 21 successes; 7 partial; 4 failures. 8 bases for 12 squadrons planned; TITAN I scheduled to be operational mid-1961; TITAN II scheduled operational early 1963; first silo launch scheduled in May; first TITAN II in Nov.
TYPHON (Navy)	Westinghouse, prime; Bendix propulsion	Medium and long range seagoing anti-missile missiles; formerly called SUPER TARTAR and SUPER TALOS; solid booster and ramjet sustainer; conventional; supersonic	Early R&D; may be used on hydrofoil destroyers
WAGTAIL (Air Force)	Minneapolis-Honeywell, prime	Air-to-ground; low-level; solid; designed to climb over hills and trees	R&D
WILLOW (Army)	Chrysler, prime	Highly-classified missile	R&D
ZUNI (Navy)	Naval Ordnance Test Station, prime Hunter-Douglas, propulsion	Air-to-air, air-to-surface; solid; unguided; 5-m. range; conventional	Operational



Space Vehicles

AGENA (Air Force)	Lockheed, prime; Bell, propulsion	1700-pound satellite after burnout; AGENA B stop-start 2450-lb. engine; about double fuel capacity of AGENA A	Used in DISCOVERER program; larger AGENA B also to be used with ATLAS and THOR
BLUE SCOUT (Air Force)	Aeronutronic, prime; Minneapolis-Honeywell, guidance; Aerojet/Hercules, Thiokol, propulsion	Solid multi-stage booster based on SCOUT components	Launchings 3: 2 successes; 1 partial
CENTAUR (NASA)	Convair, prime; Pratt & Whitney, propulsion; Minneapolis-Honeywell, guidance	Pair of LOX-liquid hydrogen engines; 30,000 lbs. total thrust, atop ATLAS booster, capable orbiting 8500 lbs. launching 1450-lb. space probe.	First test flight in 1961; first engine delivered
DELTA (NASA)	Douglas, booster; Bell, guidance; Rocketdyne/Aerojet/ABL, propulsion	Successor to THOR-ABLE; upper stage guidance; 480 lb. payload capacity	Interim launch vehicle for TIROS-ECHO; being used for other satellites and one deep space probe
JUNO II (NASA)	Marshall Center/Chrysler, prime; Ford Instrument, guid.; Rocketdyne/JPL, propulsion	Early deep space booster; small payload	Phasing out
NOVA (NASA)	No prime announced; Rocketdyne, propulsion	Clustered 6-12 million lb. booster plus upper stages	R&D on 1.5 million lb. F-1 engines
ORION (Air Force)	General Atomic	Space booster launched by series of atomic explosions	Advanced engineering studies under way; tests may be attempted
PHOENIX (Air Force)	No contracts announced	Recoverable booster—possibly a modified F-1.	Studies
PROJECT 3059 (Air Force)	Aerojet-General, Grand Central, propulsion	Solid motor in 1 million to 2 million lbs. thrust class	Research determining feasibility; NASA contracting complementary studies with United Technology Corp.
ROVER (NASA, AEC)	No prime announced	First nuclear rocket: KIWI non-flying test engines and NERVA flight engines	Contracts to be let this year
SATURN (NASA)	Marshall Center, prime and booster; Douglas and Convair, upper stages; Rocketdyne, booster and mid-stage engines; Pratt & Whitney, top-stage engines	Series of multistage vehicles based on 1.5-million-lb. clustered booster and various upper stages of LOX-liquid hydrogen engines. Early model to orbit 20,000-lb. payload	Second static tests ended; flight booster to be static-tested this spring for summer flight; flight with live upper stages scheduled 1963
★**SCOUT** (NASA)	Chance Vought, prime; Minneapolis-Honeywell, guidance; Aerojet-General/Hercules/Thiokol/ABL, propulsion	Solid four-stage satellite launcher; 200 lb. payload in orbit	SCOUT 4 launched. EXPLORER IX Feb. 16. Four more SCOUT flights in '61 completes R&D; Navy proposing SEA-SCOUT for seaborne surface launch, would be based on POLARIS and SCOUT
THOR-ABLESTAR (Air Force-NASA)	STL, prime; Rocketdyne/Aerojet-General/ABL, propulsion	Three-stage vehicle, orbital capability 800 lbs. Upper stage has restart engine	THOR-ABLE phased out. THOR-ABLESTAR operational in TRANSIT and COURIER



Satellites in Orbit

EXPLORER I (30.8 lbs.) U.S. Launched 1/31/58, est. life 7-10 years. Orbits earth; perigee 220 m., apogee 1122 m., period 106.7 min. (Discovered Van Allen Belt); not transmitting.

★**VANGUARD I** (3.25 lbs.) U.S. Launched 3/17/58, est. life 200-1000 years. Orbits earth; perigee 407, apogee 2449, period 133.9; transmitting.

LUNIK I "MECHTA" (3245 lbs.) Russia, Launched 1/2/59. Believed to be in orbit around Sun on 15-mo. cycle; not transmitting.

VANGUARD II (20.7 lbs.) U.S. Launched 2/17/59, est. life 100-250 years. Orbits earth but is "wobbling"; perigee 343, apogee 2053, period 125.4; inclination to equator 32.88°; not transmitting.

PIONEER IV (13.4 lbs.) U.S. Launched 3/3/59. Orbits Sun, and achieved primary mission—earth-moon trajectory; not transmitting.

EXPLORER VI "PADDLEWHEEL" (142 lbs.) U.S. Launched 8/7/59, est. life to Aug., 1961. Orbits earth; initial perigee 156, initial apogee 26,357, initial period 12½ hrs. present orbit uncertain.

★**VANGUARD III** (about 100 lbs.) U.S. Launched 9/18/59, est. life 50-150 years. Orbits earth; perigee 322, apogee 2312, period 129.8; not transmitting.

★**EXPLORER VII** (91.5 lbs.) U.S. Launched 10/13/59, est. life 30-40 years. Orbits earth; perigee 344, apogee 670, period 101.1; transmitting.

★**PIONEER V** (94.8 lbs.) U.S. Launched 3/11/60, est. life forever. Orbits Sun, interplanetary environment probe; completed one full orbit 1/16/61; aphelion .9931 au, perihelion .8061 au; not transmitting.

★**TIROS I** (270 lbs.) U.S. Launched 4/1/60, est. life 50-150 years. Orbits earth; picture-taking weather satellite; perigee 429, apogee 468, period 99.2; transmitting.

★**TRANSIT 1B** (265 lbs.) U.S. Launched 4/13/60, est. life 6 years. Orbits earth; perigee 229, apogee 421, period 95.0. First R&D navigation satellite. Not transmitting.

★**SPUTNIK IV** (10,008 lbs.) Russia. Launched 5/15/60, est. life 2-3 years. Orbits earth; initial perigee 188, apogee 229—changed to 191/429 on 5/19; last reported—perigee 175, apogee 334, period 92.7. Test of support systems, cabin, for manned space flight; attempt to return from orbit failed; payload, case and two pieces now in orbit. Not transmitting.

★**MIDAS II** (5000 lbs.) U.S. Launched 5/24/60, est. life 8-15 years. Orbits earth; perigee 297, apogee 316, period 94.3. Telemetry for IR scanning failed two days after launch. Transmitting.

★au:

TRANSIT II-A (223 lbs.) U.S. Launched 6/22/60, est. life 50-200 years. Orbits earth, perigee 389, apogee 650, period 101.6. Transmitting.

NRL SOLAR RADIATION SATELLITE I (40 lbs.) U.S. Launched 6/22/60 with TRANSIT II-A, est. life 50-200 years. Orbits earth; perigee 381, apogee 657, period 101.6. Not transmitting.

★**ECHO I** (132 lbs.) U.S. Launched 8/12/60, est. life 2-16 years. Orbits earth; perigee 790, apogee 1139, period 117.1. First successful orbiting of passive communications satellite.

★**COURIER 1B** (500 lbs.) U.S. Launched 10/4/50, est. life 200-500 years. Orbits earth; perigee 604, apogee 750, period 106.9. First successful launching of delayed active repeater satellite. Transmitting.

★**EXPLORER VIII** (90 lbs.) U.S. Launched 11/3/60 by JUNO II, est. life 20-50 years. Orbits earth, perigee 262, apogee 1410, period 112.5. Provides ionospheric measurements for communications. Not transmitting.

★**TIROS II** (280 lbs.) U.S. Launched 11/23/60, est. life 200-500 years. Orbits earth; perigee 378, apogee 462, period 98.2. Transmitting.

★**SAMOS II** (4100 lbs.) U.S. Launched 1/31/61. Orbits earth; perigee 295, apogee 343, period 94.9. First R&D reconnaissance satellite.

★**VENUS PROBE** (1419 lbs.) Russia. Launched 2/12/61, aphelion 1.019 au, perihelion 0.7183 au. Expected to reach Venus by mid-April.

★**EXPLORER IX** (15 lbs.) U.S. Launched 2/16/61. Orbits earth; perigee 413, apogee 1587, period 118.3. A 12-ft. "polka dot" balloon.

★**DISCOVERER XX** (2450 lbs.) U.S. Launched 2/17/61. Orbits earth; perigee 176, apogee 463, period 95. No attempt to recover 300-lb. capsule because of malfunction.

★**DISCOVERER XXI** (2100 lbs.) U.S. Launched 2/18/61. Orbits earth; perigee 151, apogee 608, period 97.0. Carried IR equipment for MIDAS program to measure background radiation from earth.

★**EXPLORER X** (78 lbs.) U.S. Launched 3/25/61. Orbits earth; perigee 110, apogee 112,500, period 5012. Optical-pumping magnetometer.

★**DISCOVERER XXIII** (2100 lbs.) U.S. Launched 4/8/61. Orbits earth; perigee 183, apogee 394, period 93.9. Capsule ejected in wrong direction, sending it further into space. Transmitting.

★**EXPLORER XI** (82 lbs.) U.S. Launched 4/27/61. Orbits earth; perigee 301, apogee 1111, period 108.05. Measures gamma rays from the stars absorbed in earth's atmosphere.

(Orbital data is latest official information as of 1200 Z, April 25)

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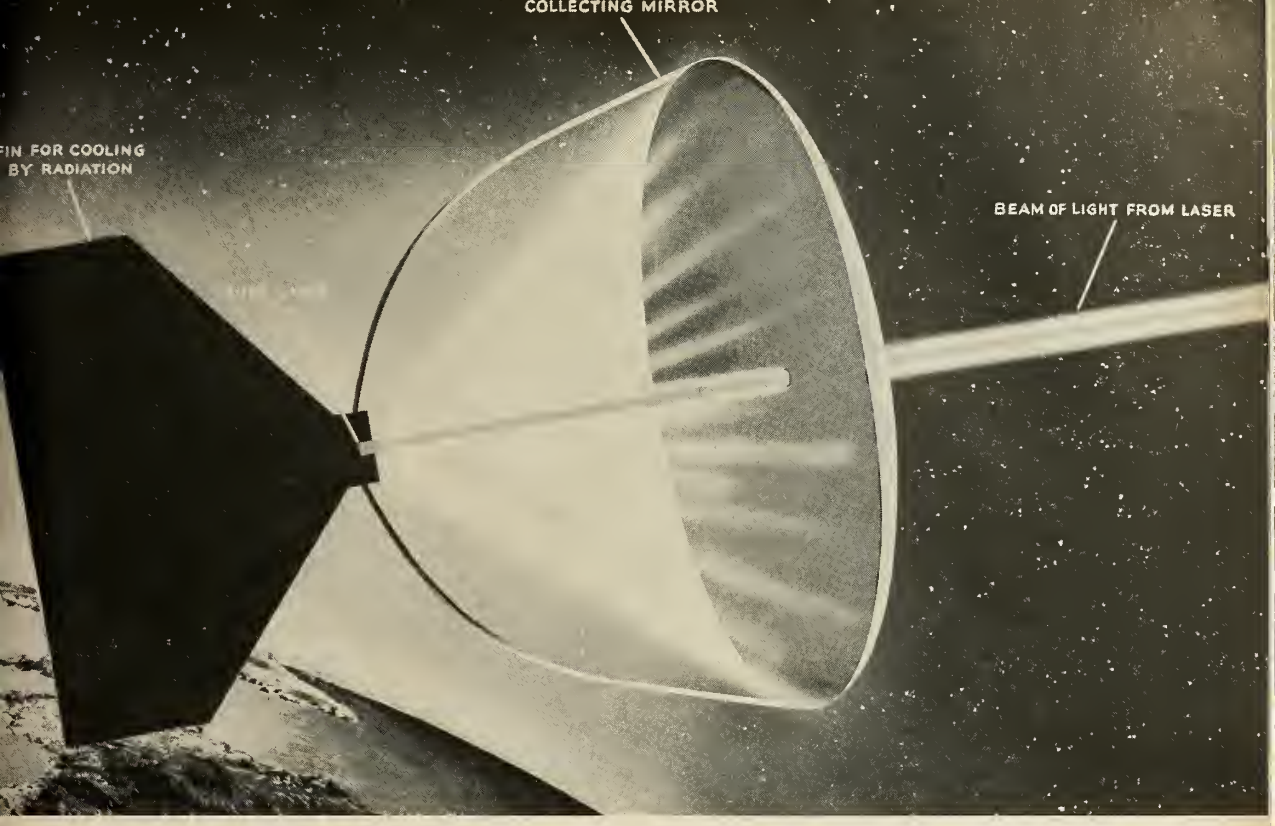
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$$I_{sp} = \frac{F_n}{\dot{m}_p}$$

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MARTIN
DENVER DIVISION



SUN-POWERED LASER for space communications (artist's conception) is being studied by American Optical for Air Force.

optics

Laser, Fiber Optics Technologies Join

by Charles D. LaFond

SOUTHBRIDGE, MASS.—Lasers and fiber optics, two new and seemingly divergent technologies, are slowly being drawn together.

Advanced research at American Optical Company's Research Center here indicates that glass fibers serving as dielectric waveguides might be used as a lasering medium. This might achieve laser action at relatively low-power levels, and provide mode selection and mode coupling surpassing a Fabry-Perot interferometer.

The Center is also studying, for the Air Force, the feasibiliity of building a sun-powered laser (using conventional synthetic ruby) for space use which would have a coherent continuous-wave output.

• **Merging sciences**—As these two technologies complement one another, so do the broad fields of electronics and optics. In the past, it has been the electronics manufacturer which has built up its optics capability. Now a countering trend has developed: the optics leaders are assembling an array of electronics and electro-optical specialists. Coupled with their already impressive majority of optics scientists and engineers, these companies can offer an imposing new body of talent.

With the development of lasers (light amplification by stimulated emission of radiation), the gap between optics and electronics is forever bridged.

The laser probably is the epitome of subtle union. With the parallel emergence of fiber optics, which offers a method of handling and carrying electromagnetic energy in the visible and infrared regions, the bridge is made indestructible.

Already, the drive is on to employ both developments in highly-advanced computers, communications, end-fire antennas and surveillance systems.

• **Space laser**—The present $91,000 contract held by AO from Wright Air Development Division, Dayton, Ohio, is for a one-year study to determine feasibility of a sun-powered laser system for space use.

There is significance in the unusual reaction time of WADD in its Request for Quotation for this contract. The RFQ was sent out in August of 1960—or roughly one month following the revelation of Dr. Theodore H. Maiman's laser development at Hughes Aircraft Co.

In the past, it has been shown that a laser requires 5000-5200°K equivalent temperature minimum from a black-body source. This has been readily available only from a flash tube. And, of course, the output is pulsating.

For space use, however, the sun offers an ideal continuous energy source since it radiates as a black body at 6000°K.

Under the present contract, AO will investigate three major components for a solar-driven ruby-laser system: the collector and associated optics, the laser, and the heat exchanger.

TRG, Inc., under a companion $30,000 WADD contract, will work closely with AO to develop a modulator for the system.

Contract requirements are necessarily broad. Types of subsystems are not specified and—except to consider a tentative collector size maximum of one square meter in area—AO can use wide latitude in studying all practical hardware configurations.

The optical considerations for optimizing such a system will receive heavy emphasis in the study, according to AO's Dr. Charles Koester. These will include collector configuration, filter assemblies, imaging optics, and whatever transmitting output optics are deemed necessary.

Not only will it be necessary to determine required image reduction for the best working energy intensity, but laser-output spread must be reduced as far as practicable below today's typical beam-spread of 0.5 degree. Improvements in laser material will be sought to further narrow beam-spread.

Also, studies will be continued to determine the best laser configuration for this space application.

Output requirement in the contract calls for 10^8 watts/steradian.

• **Problems imposing**—The problems to be surmounted in developing a practical sun-powered laser are numerous. Essentially, the overall task is to collect sufficient solar energy (radiation density is 1.38 kw/sq. meter) to produce the necessary energy density on the laser to effect inversion and cause the continuous-wave lasering.

So far, says AO project director Ed Dixon, the process itself is not completely defined because of by-products of heat which reduce the synthetic ruby efficiency.

The whole process, Dixon said, involves five principal operations: (1) collect the sun's energy; (2) reject unusable energy; (3) obtain the necessary energy density in the laser for pumping; (4) transmit the coherent induced emission; and (5) dissipate the heat energy.

Energy rejection involves the exclusion of energy beyond the useful absorption bands to keep the ruby at proper temperature (20°C). This could be accomplished with multilayer thin-film filters or with more conventional optical filters, Dixon said. A problem here is the prevention of filter deterioration near the focal point.

Pumping energy involves the basics of lasering. To achieve inversion (more ions in an excited state than in a lower state) using a typical synthetic ruby with 0.05% chromium doping, the pump must supply light in the absorption lines of ruby equivalent to a blackbody source of about 5000°K to start oscillation. Thus, energy losses must be reduced to the minimum to get an equivalent temperature.

Quantum efficiency of the laser is about 70%; therefore, in satisfying the heat problem, the useless 30% going to heat energy must be dissipated.

Also, re-emission is at a wavelength of 0.694 microns, while input wavelength is about 0.550 microns; thus the lasering process itself produces heat due to the difference in energy between a green and a red photon.

• **Fiber uses needed**—A burgeoning field such as that existing now in fiber optics actually forces development. So far, however, technical and production-technique advances appear to have outdistanced applications.

It is not, apparently, that the potential is unrecognized, but rather that the products marketed so far are almost all custom-produced. Despite this AO felt confident enough that a real market exists to create a separate department and sales group just to handle these new products.

Much of the present research in fiber optics is directed toward developing finer and more perfect fibers for more sophisticated uses. Rather than just light pipes, new bundles will be employed to handle frequencies in the visible portion of the spectrum—much as microwave is now carried in electronic systems.

A fiber optics bundle employs fine diameter glass rods to transmit light by repetitive internal reflections throughout the length of each.

In a single fiber, almost total reflection occurs if the surface quality is very high, thus preventing surface scattering. A typical 50-micron fiber reflects a light ray 3000-4000 times per foot.

But when two glass fibers are within a half-wavelength of light apart, light can leak from one to the other. By cladding each fiber with a thin jacket of transparent material having an index of refraction less than that of the fiber core, leakage is effectively stopped. Optical glass so far has proved to be the most effective light insulation.

By gathering the fibers into a bundle in such a manner that the fiber terminations are in the same arrangement at each end, image transmission is possible.

Bundles can be loose, fused, or fused and tapered. A tapered bundle enlarges or reduces an image as the ratio of its end cross-sectional areas.

The next step in its glass fiber optics development, says AO, is to evolve techniques and equipment for the mass production of fibers in varying sizes, materials, refractive indices.

The advances in fiber-optics development here have been significant over the past year. Finding applications and developing bundles for specific uses have not received the same emphasis. It appears that the technology has moved along much faster than could have been anticipated.

AO has successfully drawn arsenic trisulfide and assembled incoherent bundles for use in infrared detection.

At the same time, it has advanced the equipment used for drawing these clad fibers from limited laboratory-type to production-type.

Fifty-micron fibers having a 10-micron-thick cladding can now be drawn easily at a rate of 20,000 ft./min. with a single simple furnace. Scientists here are now attempting to build the first coherent bundle of arsenic trisulfide.

Currently, AO is developing a 5-in., fused fiber-optics face plate for a cathode-ray tube. Being developed under a WADD contract, the unit will permit contact photography of an image on a scope at about a speed 50 times faster than with conventional camera rigs.

• **Fiber laser next?**—The company has several projects now under way to determine the feasibility of a laser employing fiber optics for the lasering geometry.

According to Dr. Elias Snitzer, glass still looks like the best material for use in fiber bundles. More important, in this instance, it seems to offer interesting geometry for lasers, the scientist said, because it may permit obtaining a single mode necessary for coherent continuous wave propagation of light.

To achieve this end, Snitzer said, it will be necessary to reduce fiber cross-section and build up a good standing wave when the energy is pumped above threshold in the laser.

The basis, then, of the present program involves the use of fiber optics as dielectric waveguides to provide a resonant structure for mode selection in a laser system.

In a recent paper published in the *Journal of Applied Physics*, January, 1961, Dr. Snitzer stated that the mode coupling in such a dielectric waveguide would be intermediate between that of a Fabry-Perot interferometer (FPI) and a closed structure like a metallic waveguide.

While the fiber-optics laser offers better mode selection and stronger mode coupling than the FPI, it also has certain disadvantages. A major one, Snitzer noted, is that of getting pump power into the small-volume fiber.

He believes, however, that with proper fiber design and illuminating optics this can be overcome. Because of the better mode selection characteristic, pump power in the fiber is used more efficiently. Snitzer believes that laser

(Continued on page 45)

NASA Finds Solar Probe Is Feasible

Preliminary study covers trajectory, communications and power sources; high burnout velocity is seen as crucial factor

by John F. Judge

SPACE PROBES approaching as close at 4-to-5 million miles to the Sun are feasible if burnout velocities ranging between 50,000 and 100,000 feet per second can be attained.

D. W. Dugan of the Ames Research Center, National Aeronautics and Space Administration, says another prerequisite is that the capabilities of the instrumentation and communications system must be able to acquire data superior to the information obtainable from near-Earth satellites and ground observatories.

In a report on a preliminary study of a solar probe mission, Dugan says the nearness of the probe's approach to the Sun may be limited by the temperature tolerance of the structure or the instrumentation.

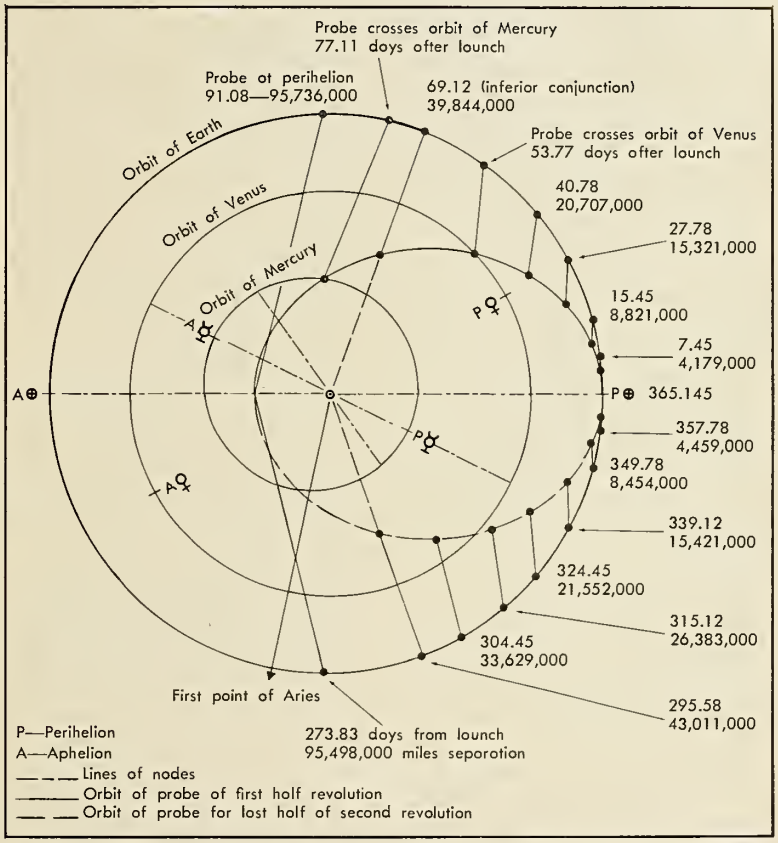
Although the temperature of the visible solar corona is estimated at 1,000,000°K, this portion of the solar atmosphere is apparently so tenuous that the passage of a body through it results in inappreciable deceleration and heating. In addition, the corona extends only a few solar radii from the Sun.

Heating of the probe from the relatively few collisions with corona particles may be negligible compared with that due to thermal radiation absorption.

Dugan feels that solar flares may have an effect, but data is so slim in this respect that such considerations were not included in the report.

The chief problem is the dissipation of solar-absorbed heat. Dugan says a spherical probe with uniform surface temperatures could approach no closer than 0.6 astronomical units.

• **Optimum probe configuration**—The next consideration is a specially oriented spherical probe which presents only one side to the Sun. At one extreme the rate of heat transmission might be considered great enough to maintain the unexposed areas at the same uniform temperature as the exposed area, creating a situation identical to the revolving sphere. At the other extreme, the two hemispheres could be completely thermally isolated—one side receiving maximum heat and the other being maintained essentially at absolute zero. This latter approach would permit operation somewhat closer to the Sun.



TRAJECTORY OF A PROBE which reaches its aphelion almost simultaneously with an inferior conjunction with respect to Earth and Sun. Time of launch is early January, when Earth is at perihelion, and cuts 1500 ft/sec. off similar summer launch.

Dugan maintains that higher ratios of radiating-to-absorbing surfaces can be achieved in a configuration consisting of a hemisphere followed by a right conical frustum. The longitudinal axis would be constantly pointed towards the Sun.

As far as the heating problem is concerned, this type of probe could function about 0.05 AU's from the Sun.

The report includes a preliminary study of the three-dimensional motion of a body launched into a hyperbolic orbit from the Earth in such a direction that it achieves an orbit of at least perihelion distance about the Sun.

In the discussion of his results, Dugan points out that the magnitude of the velocity requirements are quite large when compared with that for currently proposed Martian or lunar missions. Dugan says a six-month orbit is attractive because it passes well within the orbit of Mercury and close enough to the Sun that any data obtained would be of considerable value. In the second place, the six-month orbit has a total velocity requirement of about 54,000 ft. sec. This is less than that required to reach the orbit of any other planet or to escape the solar system altogether.

For a typical solar probe mission, launching errors which might normally be expected on the basis of current guid-

ance capabilities will be of little or no consequence. In the case of an orbit which is to closely approach Earth 1 year after launch, the initial guidance requirements are much more stringent. Depending on the closeness desired, mid-course guidance might be necessary.

The effect of other bodies on the probe in Dugan's restricted three-body trajectory study will be negligible if the time of launching is such that the distances of the probe relative to the moon, Venus, or Mercury as it crosses their orbits are sufficiently large that perturbations can be neglected.

• **Communications analyzed**—There are, of course, other considerations which need to be taken into account in planning a solar-probe mission, says Dugan. Some problems, such as attitude control and protection of vulnerable components against meteoroids, may be considered to be within the experience of current and past missions.

Provision for considerably longer life than heretofore required will be necessary, but this does not appear to demand much more than some relatively moderate increase in weight. On the other hand, inasmuch as a solar-probe mission presents problems in communications not found in current missions, Dugan questions whether it is possible to solve these problems without entailing such great power requirements and weights that the mission becomes impractical.

The chief problem is the tremendous distance over which communications need be maintained. The distance between the Earth and probe at perihelion of the latter is of the order of 10^8 miles. Galactic background noise, solar noise during periods near inferior conjunctions, and Doppler effects present other difficulties.

The rate at which data would be transmitted from a probe is not likely to be only a few bits/sec., since to justify a solar-probe mission the accuracy and amount of information should be greater than that which could be obtained from near-Earth orbits. Dugan did not attempt an analytic treatment of the whole communications problem. Rather, a look is taken at the present and anticipated state of the art of deep-space communications and of auxiliary-power generation to obtain an order-of-magnitude estimate for the weight which might be required to provide the power for adequate communications in a solar-probe mission.

• **Ground support** — Considerable effort is currently being made to achieve adequate deep-space communications for future interplanetary missions. A number of facilities, devices, and techniques being developed for this purpose show promise of extending the range and usefulness of communications for space missions for modest power costs.

Among these Dugan mentions the construction of several large, steerable ground-based antennas; the development of a steerable spaceborne antenna of moderate gain; the design of stable oscillators of very-high frequencies; the application of masers to reduce receiver noise to very-low levels; and the application of information theory to increase the amount of information which can be carried on a communication channel of given bandwidth.

It was estimated that within a four-year period, the communications system used in the lunar mission *Pioneer IV* could be extended to provide a two-way link over a distance as large as 4×10^9 miles with a transmitter output power of 100 watts and a receiver bandwidth of 30 cps. An Earth-seeking vehicle antenna with a 36 db gain was assumed in the estimate. If the frequency of 960.05 megacycles/sec. used in the lunar mission is retained the diameter of this vehicle antenna can be calculated to be approximately 27 ft.

For a solar probe, the antenna diameter should be no larger than that of the probe itself if provision for shielding from solar radiation is not made. There may be an optimum size for the antenna such that the ratio of the weight of shielding required for thermal protection has a maximum greater than unity.

Dugan assumes that the probe antenna is no more than 3 ft. in diameter. A simple calculation then shows that the two-way communications system described, but with the smaller probe antenna, would require a transmitter power output of about 5 watts to have a range of 10^8 miles. If the transmitter efficiency of 7.5% obtained in the *Pioneer IV* experiment were not improved in the time indicated, the required input to a vehicle transmitter would be nearly 70 watts.

It is possible that the bandwidth would need to be increased two- or three-fold to meet requirements of a minimum information rate in a solar-probe mission. This would require greater transmitter power, two-fold for a two-fold increase in bandwidth, etc. In any case, in view of the rapidly advancing state of the art of deep-space communications, the spaceborne power requirements for communications in a solar-probe mission can be expected to be only a few hundred watts at the most within the next few years.

• **Power requirements**—Because of the extended time characteristic of a solar-probe mission, some type of power converter rather than chemical batteries will likely serve as the primary source of power.

The solar cell is not well suited to a solar-probe mission. The efficiency of this device decreases with increasing temperature, and measures used to prevent high temperatures of the cells tend to decrease output or to increase weight, says Dugan.

Other types of solar-energy converters are currently being investigated or developed. Some of these show promise of achieving attractive specific powers (watts/lb.). As an example, Dugan refers to a thermionic converter said to have produced 7.2 watts/lb. in an experimental setup, and to be capable of 17 watts/lb. in the future. One type of thermionic converter is reported to be in commercial production, to be followed by an improved version at a later date. The output of the latter type may reach 20 watts per square centimeter of cathode surface, and the thermal efficiency may be as high as 30%.

Dugan says the close relationship between solar activity and terrestrial phenomena—such as polar auroras, magnetic storms, disruption of radio communication, climate and weather—is currently recognized but the causality of the relationship is not completely understood.

In addition, solar events themselves are not adequately explained or predicted on the basis of present knowledge. Partial information is available on the corpuscular and radiative output of the Sun and the nature of the magnetic and electric fields of circumsolar space.

An instrumented probe could effectively fill this gap in data. ⌗

NOL Drop Tester Seen Trimming Costs by 90%

AN INEXPENSIVE portable shock tester developed by the Naval Ordnance Lab., Silver Spring, Md., is expected to save 9 out of every 10 dollars now being spent to insure shock reliability in electronic components.

The prototype model cost about $5000 to build, but it replaces a permanent drop-tower valued at $50,000. The new instrument can subject components weighing upwards of 100 lbs. to shocks in the area of 10,000 gravities.

The drop-tester consists of a 900-lb.-base and anvil connected by two pipe columns to a sliding carriage designed to hold the specimens.

Glass-bead shock mitigators isolate a lightweight lifting yoke mounted on the carriage.

In operation, the device is lifted to the desired height by a hoist or a mobile crane. As it raises, the carriage separates from the base. When the tester is dropped, the base plate strikes first; a fraction of a second later, the carriage strikes the anvil, transmitting shock to the specimen. ⌗

(Continued from page 18)

is the forces provided in the President's budget for FY 1962.

Initially, these forces will not have to be costed out in program package terms. But during the summer, as force proposals are submitted to the Secretary, he will want to see the program package cost implications of the alternative of continuing each force as projected. The assumption for this exercise will be issued shortly.

No one expects this force structure to be the actual one. These forces are simply present forces and weapon systems continued into the future (except where a phase-down has already been decided), with no new ones except those already funded (and a few others already approved by the Secretary), and no new equipment (again except that already funded).

This does give us a base from which to start. Clearly there will be subtractions from the base as we go along, as well as many additions.

For each program package, therefore, and where feasible and appropriate for program elements within the package, we will want the following cost information (obligational authority and expenditures; also numbers as well as cost of military personnel):

(1) How much in 1962 budget?

(2) How much implied in the specified benchmark force structure, '63-65?

(3) What alternative programs (forces, capital expenditures, etc.) do you propose, and how much will they cost—for the next 5 years? (Or more in a few cases, where appropriate.)

In general, we shall be relying on the Services to design and present imaginative proposals both for "add-ons" and reductions responsive to the general policy guidance provided by BNSP. But the Secretary will also be interested in seeing other alternatives. These will be specified in the program guidance for each program package.

• **A "Big Board"**—Finally we shall issue a schedule for program submittals so that the Secretary and his advisors can examine and make decisions on program proposals in an orderly way over a period of several months. The submission of program proposals for review by the Secretary of Defense and his staff will begin approximately June 1st. As the program packages are reviewed, the Office of Programming will advise the Secretary on the resource implications of some of the alternatives submitted.

A special program cost analysis group is being established in my office to review program element cost submissions by the Services. The Secretary will examine the program submittal and make tentative program decisions to be used in preparing the FY 1963 budget.

As program packages are approved and program decisions made during the deliberation process, a "Big Board" will be set up by the Office of Programming and thereafter maintained on a current day-to-day basis. After all program decisions concerning the FY 1963 budget have been made, the "Big Board" will reflect the total Defense structure in program package terms. As changes, deletions, additions or any other deviations from the original total of packages takes place, the Board will be so revised.

In costing end-product programs, I have said that we want the full budgetary implications included. But we also realize that we have to do what is feasible and practical this year, and that this will have to be done using statistical factors in most cases.

The question is how far and deep should one go into the support structure, for example, in tracing the cost implications. The general rules are:

(1) Try to prorate (take "slices") if the overhead or support activity varies directly with the force unit or weapon system (e.g., specialized training, spares, maintenance): but if the overhead or support activity doesn't vary, don't prorate it (e.g., academies, colleges, higher headquarters).

(2) Be very explicit about what is and isn't included. We realize that some support elements that ought really to be prorated will not be able to be this year. However, we intend to pursue this and do a better job next year.

I do want to emphasize that while statistical cost factors will be acceptable for program decision-making purposes, we do not intend to forget about the cost estimates used for program decision-making purposes when we reach the budgeting phase. Substantial discrepancies will be called to the attention of the Secretary and may necessitate revision of the program decisions.

• **Oct. 1 deadline**—This is an ambitious program. However, one of the things that gives one some confidence that we can manage a program review along these lines is that the Weapon Fact Sheets for FY 1962 which include only 145 weapons and items of equipment, account for about 75% of the procurement appropriations and about 45% of the RDT&E and the construction appropriations. Of course, as we all know, the difficult areas for this approach are operation and maintenance, and military personnel.

We expect to complete the programming phase not later than October 1, 1961. The tentatively approved program packages will then form the basis for budget submissions in the usual fashion by appropriations. The total budget will then be reviewed and recommendations made to the President by early December.

I want to emphasize that the program package concept for review and decision-making as directed toward the FY 1963 budget is only the beginning of the formulation of a continuing planning and programming/financial management process. We visualize a continuous process of review and revision to improve the system.

Toward the longer-term objectives of an integrated programming and budgetary system, the Office of Programming with the assistance of contractor personnel and consultants, will begin to test the adequacy of presently existing information systems by estimating the cost of some of the more difficult resources elements such as construction, operation and maintenance, personnel and training associated with the FY 1963 program packages.

This will take place during the late spring and early summer of this year. This effort will then be expanded during the fall and will require full participation of the Services. Broadly, the sequence and nature of this phase of activity will be along these lines:

First, we will study and define types of information, both financial and non-financial, necessary for making the top management program decisions. Then against these requirements, and with the assistance of knowledge gained in connection with the FY 1963 package work, information presently available at the OSD level will be thoroughly surveyed.

In parallel with the data survey, the Programming Office will try to design a system for clear and concise display of program package information for the Secretary of Defense and his staff on a continuing basis.

Following these steps, all military department information systems will be reviewed in order to determine the extent to which information is available or can be reoriented toward meeting the requirements of management decision information. Where the requisite information is determined to be unavailable, study will be generated in order to recommend means of acquiring it. We anticipate that this activity will continue until approximately 1 Dec., 1961.

Based on the FY 1963 program package work and the Programming Office/military departments/contractor study results, improvements will be initiated on the program packaging concept and the data systems for continued programming/financial management purposes.

We will try to guide this activity from December 1 of this year forward so as to make significant improvements in the concepts and systems that I have been discussing in time to accommodate FY 1964 program guidelines. ⁂

Republic Plant Has 7 Specialized Labs

Center geared to making sure company maintains its balanced capabilities for DOD contracts

REPUBLIC Aviation Corp. made a down payment on Space Age insurance late last month when it dedicated its $14-million Paul Moore Research & Development Center in Farmingdale, N. Y. (M/R, March 21, 1960, p. 14).

The company wants to assure itself of continuing Department of Defense and NASA contracts, which more and more often are going to firms able to show their capabilities beforehand.

Each of the Center's seven laboratories is designed as a self-sustaining unit competent to solve a particular set of Space Age problems. The fields of specialization are: space environment and life sciences, re-entry simulation, materials development, nuclear radiation, guidance and control systems, fluid systems, and electronics.

Furthermore, each laboratory is set up to compete for contracts with any



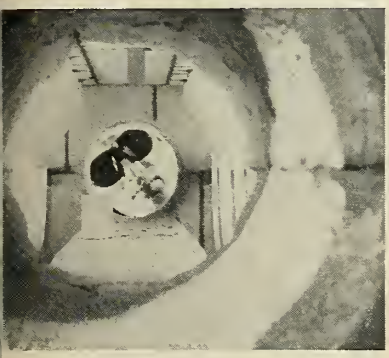
TWELVE-INCH optical flat mirror, part of a 15-ft.-long auto-collimator, provides a parallel beam of light 16 in. in diameter for Guidance and Control lab's optical system tests.



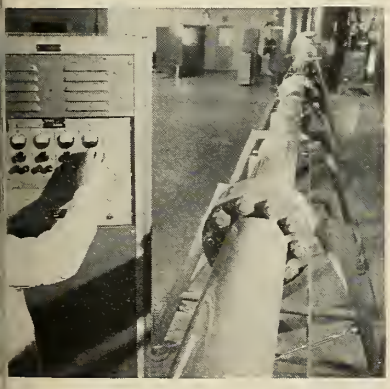
ELECTRONIC capacitor less than one-millionth of an inch thick is made under the thimble-shaped dome of a special vacuum-coating machine.

other facility in the country. In this way, Republic feels it can keep abreast of fast-paced technology and at the same time have the research laboratories possibly pay their own way.

Moreover, Republic says, the laboratories can be integrated to give the company a broadband capability for bidding on major weapon systems studies, submitting proposals and performing on contracts. ⌘



MATERIALS laboratory technician observes ceramic specimen undergoing heat treatment in special furnace able to maintain 3000°F for several days.



HIGH-PRESSURE (100,000 psi) combustion-driven Mach 20 shock tunnel, in Re-entry Simulation lab, has windows for observing re-entry effects.



THIRTY-FOOT-LONG altitude chamber, part of Space environment laboratory, is said to be only unit of its size able to simulate altitudes of more than 150 miles for testing men and systems.



TEST STAND 1-B as it nears completion. Huge structure, more than 250 ft. high, can be used for testing clustered F-1's. Note size of man (arrow).



HIGHEST THRUST ever achieved in U.S.—1,640,000 lbs.—poured from this chamber April 6 in test series preparing for firing of complete F-1.

propulsion

Preparing For All-out F-1 Tests

Last of three big stands nearly finished; costs cut by water recovery

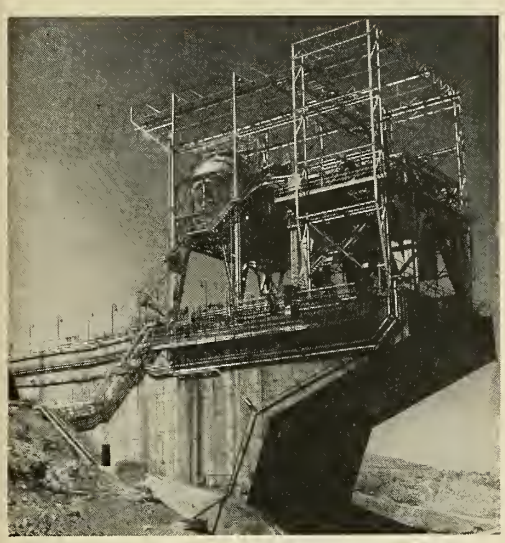
by Richard van Osten

EDWARDS AFB, CALIF.—Test facilities for the 1.5-million-lb.-thrust F-1 space engine are rapidly being completed for the first full-scale firing in July.

Some 30 to 40 thrust chamber runs have been made so far, with both the boiler-plate development model of the Rocketdyne/NASA powerplant and a prototype of the fuel-cooled thrust chamber. The latter, with a 10:1 expansion ratio, has been tested in several runs under 20 seconds to more than 1.6 million lbs. thrust since the first high-thrust run in early April. All these runs have been made on Test Stand 2-A, which was completed last June.

The next test series, first in the full-scale engine firings, will be made this summer on Test Stand 1-A, the second stand in the three-stand F-1 complex. Fuel and LOX supply systems for this stand will allow firings up to about 150 seconds, as compared to present thrust-chamber-only runs of less than 15 seconds. The stand, however, has no provisions for gimballing the vertically mounted engines during test, and will be used for static tests at something less than the hoped-for maximum thrust.

• **Ultimate test**—The real "boomer" will come on Test Stand 1-B, now nearly completed. This stand will handle two F-1 engines. It also has provisions for gimballing during test runs. Rocketdyne engineers say, however, that present



TEST STAND 1-A, second stand in the three stand F-1 complex, where first full-scale firings will be made.



PROTOTYPE thrust chamber for F-1 spews flames of more than 1,000,000 lbs. thrust in Edwards firing. Chamber has reached 1,550,000 lbs.

plans do not call for firing of more than one engine at a time. Stand design incorporates provisions for expansion to F-1 cluster firings when the program requires it.

Stand 1-B is over 250 ft. high and contains 26,000 cubic yards of concrete. Two 35-ft.-diameter tanks, mounted directly over the stand, hold 75,000 gallons of LOX and 60,000 gallons of fuel (RP-1), respectively. The LOX tank is a stainless-steel, double-wall, vacuum-jacketed unit. Because of their size, both tanks were weld-assembled at the site from pre-fabricated "orange peel" segments.

Cooling water for the stand is contained in a 1,000,000-gallon tank located on a hilltop above the facility. During a full-thrust run, six 1000-hp pumps push the water through a 5½-ft.-diameter pipe to the test stand at 75,000 gallons per minute.

Because the large amount of water required for the big stand poses a major problem in the desert area, a recovery system is used. Located in a dike-type runoff pool below the flame deflector, the system includes a skimmer to lift off any unburned fuel from the water's surface and route it to a small sump area for burning. The remaining water is pumped back to the large storage tank. This system is expected to recover slightly over 40% of the water used in each firing.

The flame deflector is unique in that cooling water is carried through 2-in.-diameter tubes from the top of the deflector to about halfway down the curved deflector surface. At this point, the water runs free from open tube ends for the balance of its trip down the deflector face. In essence, the system provides radiation cooling in areas closest to the engine nozzle, and spray cooling to the lower areas.

• **Moneysaver**—Designed by Rocketdyne, the system is reported to have cost some $75,000 against an approximate $440,000 for the more conventional cooling approach. In addition, maintenance costs are reduced because the tubes may be individually replaced, eliminating patching and welding time and the costs involved in repairs to a standard-form deflector.

When full-scale F-1 tests get under way, Rocketdyne expects to be making seven or eight engine runs per day. This, they hope, will be accomplished by the years' end. Each engine may be run at frequent intervals for as long as a month.

To support this proposed program, about 200 tons of LOX per day will be required. The existing LOX plant at Edwards can produce only 140 tons per day. A new NASA LOX plant is now under construction which will have a capability of 2000 tons daily. The LOX will be piped to the stands through vacuum-jacketed pipes.

Fuel is carried into the F-1 test site by tank cars, and stored in a 120,000-gallon tank. It is piped to each test stand as required.

• **One-day charging** — Although a high rate of F-1 engine testing is planned—with each engine remaining on the stand for several weeks, if all goes well—the big 1-B stand has been equipped with plug-in instrumentation and other connections. Wiring, pneumatic and fluid connections, where applicable, are pad-mounted with a system of quick-release connectors. It will require about one day to change engines; the engine itself can be changed in four hours, but connection and checkout of the match panels will take up the balance of the time.

During full-scale tests, between 100 and 200 critical engine parameters will be measured. All data will be transmitted from the test stand area to the control room by means of instrumentation wiring trays in walk-through tunnels which also provide access to the F-1 area test stands.

From the control center, the data will be transmitted in cryptographic form by teletype to Rocketdyne's central data processing center in Canoga Park, Calif., where it will be analyzed by preprogramed computers and returned almost immediately to the test engineers at Edwards. ⁂

Canada Steps Up Space Exploration

CARDE heads national push based on use of Black Brant series of rockets; details of solid-making process

by Bernard Poirier

CANADIAN SPACE efforts during the next 12 months will feature advanced rockets for heavy payload probes into the ionosphere and a unique "long-legged" earth satellite to be launched in early 1962.

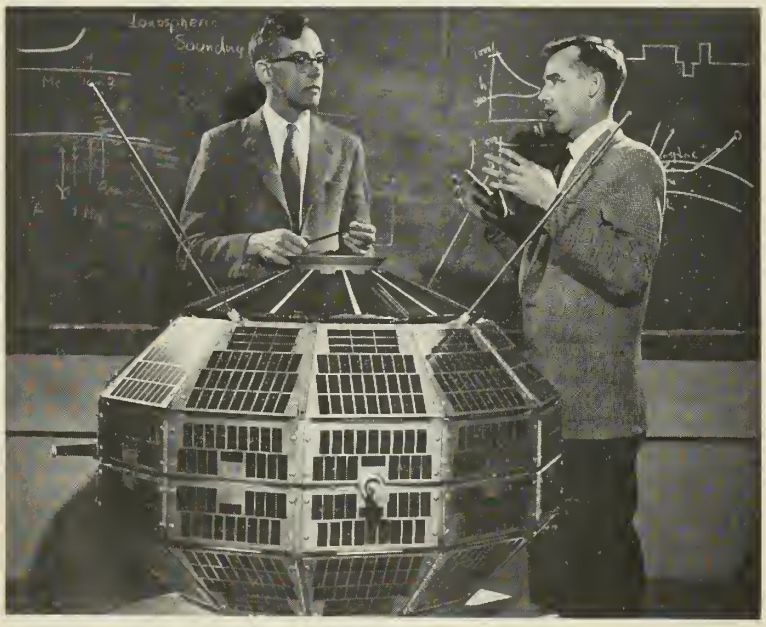
Spearheading the nation's drive is the Canadian Armament Research and Development Establishment (CARDE). This group recently flight-tested *Black Brant II* solid-fuel rockets designed to lift 150-lb. instrumentation to altitudes between 150 and 180 miles from Fort Churchill Rocket Range, Manitoba.

CARDE, moreover, will be "design authority" for new solid *Black Brant III, IV* and *V*. Prime contractor will be Bristol Aero-Industries Limited, of Winnipeg. Version *IV* is Canada's first serious two-stage effort and will lift payloads up to 250 lbs. for sub-polar probes as high as 600 miles.

Canadians said last week "numerous *BBII* vehicles will be available for a 1961 series of shots." The Bristol series is scheduled to follow the Canada-NASA satellite launching from Vandenberg AFB, Calif., as part of the two nation *Top-Side Sounder* program. (M/R, April 24, p. 18.)

CARDE and the Defence Research Telecommunications Establishment (DRTE), both under the Defense Research Board (DRB), have guided existing rocket propulsion development, satellite design and launching techniques at the Hudson Bay testing area. Program acceleration is expected with the addition of direct management by the Department of Defence Production and Bristol Aero-Industries.

The Associate Committee of Space Research of the National Research Council is coordinating test planning for experiments which will include pressure measurements by Toronto University's Institute of Aerophysics and falling-probe electron-density measurements by the University of Saskatchewan.



TWO 75-FT. ANTENNAS are unique features of Canada's satellite design for the joint Canada-NASA Top-Side Sounding project. A NASA rocket will place the satellite into orbit from Vandenberg AFB, Calif., in early 1962. Above, Dr. John Barry and Dr. Colin Franklin (center), of the Satellite team from the Electronics Wing of the Defence Research Communications Establishment, discuss Canada's space plans.

MISSILES AND ROCKETS learned the first details of CARDE's solid-propellant processes designed to maintain controlled particle size distribution in an uncaked state for six weeks or more.

• **Exclusive report**—The oxidizer process provides discrete, free-flowing and surface-dried blending of ground and unground ammonium perchlorate. A prepolymer adduct of a polyurethane binder is synthesized from the triol and totylene diisocynate in glass-lined closed pots.

The prepolymer is blended with the main diol and the remainder of the isocyanate in the propellant mixer. In reply to a query on the method, CARDE Acting Chief Superintendent at Valcartier, P.Q., R. F. Wilkinson disclosed that CARDE designed a new "3000-lb. horizontal mixer incorporating several unique features."

With its own transfer wheels on a 54-in. track, the mixer forms a vacuum seal and dumps the propellant into the engine case at the casting site. Internally, the ribbon has a double blade to blend the crystalline oxidizer and liquid binder and to feed the propellant towards the centrally located dumping valve.

Once vacuum-cast in an inhibitor-coated engine case, the mixer is withdrawn for solvent cleaning. The rocket engine is later capped and hot air is circulated between the casting bell and the engine case for curing at programed temperatures to 130°F.

The casting mandrel is withdrawn from the rocket engine, approximately 19 ft. long and 17 in. ID, for inspection against non-adhesion, cracks and other anomalies. A barricaded CARDE control console is used to minimize personnel hazards in mixing, blending and curing operations.

• **Reliable fuel is aim**—According to DRB spokesmen in Ottawa, *Black Brant II* was designed with reliability as the primary objective; payload/altitude is secondary. They said two rockets have been tested and "the maximum longitudinal acceleration measured at all-burnt (burnout) was 16.7 g with maximum laterals of 1.2 and 0.87 g."

The vehicle answers requirements



BLACK BRANT I has been used heavily in Canadian space research. Black Brant II is only slightly larger, but has greatly increased payload capability.

for an inexpensive Canadian instrument to continue the space studies in which *Nike-Cajun, Aerobee-150* and *Black Brant I* rockets have already been used.

Its reliability objectives are now accomplished, and *Black Brant II* also increases altitude performance by about 150% and payload capability by almost 100%. (M/R, Oct. 3, 1960, p. 25.)

The new vehicles are expected to use the existing 15 ft. underslung, zero-top off launcher at Fort Churchill. The launcher is fixed in azimuth on a bearing of 093° true, with elevation angles between 60° and 85°.

The launcher is exposed, and Rupertland climate factors restrict the time of year when satisfactory launching conditions exist. As a result, the first 1961 series of shots may not take place before the end of May.

One of the principal tracking stations for use with *Black Brant II* will be the ICBM Warning installations set up by DRB/USAF at Prince Albert Radar Laboratory, Saskatchewan. PARL has also been identified as one of the ground receiving stations for Canada's 1962 satellite project with NASA.

Scientists from DRTE, MIT's Lincoln Laboratory, Canada's Research Medical Laboratories at Downsview, Ontario, the Dominion Observatory and the Department of Transport have figured prominently in preparations for Canada's first big year in space research. Further related studies may also be sponsored at Suffield Experimental Station near Medicine Hat, Alberta.

• **New version heavier**—Appearance of *Black Brant II*, whose design study was ordered in 1959. differs only slightly—the *BBII* has a 11½° nose cone angle compared to 15°, which explains the increased payload area. Other differences are:

	Black Brant I	Black Brant II
Overall length	292.0 in.	332.0 in.
Nose cone length	62.3 in.	86.0 in.
Burning time	20 secs.	26 secs.
Thrust	20,000 lbs.	16,000 lbs.
Tot. Imp. sec. lb.	400,000	420,000
Engine weight	1758.5 lbs.	2095.0 lbs.
Filled total weight	2492.8 lbs.	2782.3 lbs.
Payload area cu. ft.	4.0	6.2

The conical and forward body section of *BBI* is skinned with 12 SWG 4130 steel and the afterbody section is cast in DTD 304 light alloy. The conical and forward body section of *BBII* is cast magnesium-zirconium EZ33A in thicknesses from 0.5 in. fw'd to 0.45-0.38 in. aft, with 0.40 in. on the body section.

• **Plastic nozzle research**—*BBI* fins use DTD 368 web and spar wooden matrix structure with steel skins covered with a phenolic-soaked durestos material. The leading edge is cuffed with stainless steel and the fin ring is a high-strength, light-alloy DTD 683 casting.

BBII uses magnesium alloy EZ33A sand castings for the central section with insert leading and trailing edges in NEMA Grade AAA laminated phenolic asbestos. The fin roots are flaired and bolted to a central support ring, which in turn is bolted to the rear engine face.

CARDE nozzles are 4130 steel for body and expansion cone with graphite insert in the throat. Metal surfaces exposed to hot-propellant gases are oversprayed with 0.005-in. ceramic. It has been found satisfactory to use steel as a heat sink to maintain surface temperature below 500°F.

One DRB spokesman described the CARDE-designed nozzle as "weighing 43 lbs. compared to 70 lbs. for a corresponding commercial nozzle." He added, "Plastic expansion cones and complete plastic nozzles are being developed to further reduce the weight in this rear position." ⁂

Lasers & Fiber Optics

(Continued from page 34)

action should be initiated at power levels well below that of an FPI cavity.

Solving the problems in such a system development will depend considerably on finding the right laser material. Many materials are difficult or even impossible to draw into the desired shape and size.

• **Wavelength studies**—In his experiments in the study of dielectric waveguide modes in the visible spectrum, Snitzer has used clad fibers with core diameters from 0.1 to 5.5 microns. Core and cladding indices of refraction were 1.56 and 1.52, respectively.

Cladding diameters in each case were 100 times core diameter. The outer surface of the cladding was painted black to absorb stray light from within.

Fibers were finally encapsulated and ends were cut, ground, and polished. Overall length was approximately one inch for all mounted fibers.

In the tests, fibers were illuminated with monochromatic light with a medium-intensity carbon arc source.

With a suitable optical configuration and with proper choice and adjustment of the illuminating beam, Snitzer was able many times to obtain single modes. More important, his observations when identified very closely approximated the predicted wavelength for each preselected mode.

This work is being carried out under a contract with AF Cambridge Research Center to investigate the use of fibers in the study of dielectric end-fire antennas. Such simulations will permit making radiation measurements in the laboratory quickly and easily by means of simple photographs. ⁂

soviet affairs

By Dr. ALBERT PARRY

Pregnancy in cosmonaut-women

and virility in cosmonaut-men may well be the subjects of space-medicine research in Russia as Soviet scientists prepare their next pilots for orbiting. It should not surprise us if a Russian woman is soon launched into outer space and, on returning to earth, is presented as a happy and healthy mother-to-be. The effects of radiation and other outer-space conditions have already been studied by Soviet space specialists in the reproductive organs of Marfushka ("Little Martha"), the female rabbit who was sent up ballistically and successfully recovered on July 2, 1959. And the female dog Strelka ("Little Arrow"), who orbited the earth in Spacecraft Two on August 19, 1960, gave birth to six sturdy pups in November.

At the press conference

of the Academy of Sciences in Moscow on March 28, 1961, as Strelka and her healthy pups were proudly exhibited, Academician Norair M. Sisakian, a noted biochemist, announced: "All six of Strelka's progeny are developing normally. The mother has manifested all the traits that go with the usual maternal behavior. Our research on these animals, just completed, has proved that no dangerous consequences to the functioning of their organs have stemmed from the space flight. This problem has an important bearing on our preparations for man's orbiting."

The flies taken

on the same outer-space trips in 1960-61 have been subjected to "researches of genetic character," which evidently have been no less successful. These researches also augur well for man's reproduction of his own species as a new cosmonautic race—says Professor Vasily V. Parin, a prominent member of the Soviet Academy of Medical Sciences in charge of outer-space physiological research.

Weightlessness with comfort

was described by Major Yuri Gagarin as lasting the entire 89 minutes of his flight in orbit on April 12. Gagarin apparently had experienced some brief moments of weightlessness during his training period, probably in an airplane much like the Air Force C-131 which by climbing in a ballistic trajectory following a steep dive can produce about a half-minute of weightlessness. An official Soviet report of April 25 described the preliminary training experiences as: "It was established that all the selected cosmonauts possess a good ability to endure weightlessness. It was also shown that, under the conditions of weightlessness lasting up to 40 seconds, the cosmonaut can eat food liquid, semi-liquid, and solid; can perform delicate coordinated acts, such as writing or purposeful hand motions; can maintain communication by radio; can read; and, besides, can orient himself visually."

Rocket fuel making

is the subject of a play written by Nicholas Virta, a Soviet author, and currently staged in a Moscow theater. The title is *The Sky Is High in the Summer,* and the second act takes place in a Russian rocket-fuel laboratory. The *Izvestia* reviewer declares that this particular act "has turned out to be the weakest," even though its aim is to show "the dramatic quality of scientific search." The play's text is as yet unobtainable outside the Soviet Union.

The latest dictionary

of Russian and English rocketry terms has just come out in Trenton, N. J. It is A. Kramer's *Russian-English Rocket and Ballistic Missile Dictionary,* containing more than 10,000 words. The book also has a useful list of reference works—Soviet dictionaries and scientific magazines—with the aid of which the Russian-American author, an engineer graduated from a Russian polytechnical institute, has prepared his volume. (For a description of earlier dictionaries and glossaries in our field, see my column in M/R, July 11, 1960.)

Industry

(Continued from page 16)

THOMPSON RAMO WOOLDRIDGE has established a new operating group, the Electronic Systems and Equipment Group. It will include the operating divisions formerly known as the company's Commercial Electronics and Intellectronics Groups. M. E. Mohr, vice president and formerly general manager of the Intellectronics Group, has been appointed General Manager of the new group. Divisions included in the group are Ramo-Wooldridge Division, TRW Computers Company, Dage Division, Educational Electronics, Bell Sound Division and Bel Canto Stereophonic Recordings Inc.

ATLANTIC RESEARCH CORP. has acquired a 15% interest in Nuclear Science and Engineering Corporation of Pittsburgh. Atlantic's president, Dr. Arch C. Scurlock, will be elected to the board of directors of Nuclear Science and Engineering. Atlantic Research recently expanded its electronics business by acquisition of Jansky and Bailey. Inc. of Washington, D.C., and Northeastern Engineering, Inc., of Manchester, N.H.

THIOKOL CHEMICAL CORP.'s Utah and Wasatch Divisions have now been combined in a single organization known as the Wasatch Division. Edward F. Nauman, formerly general manager of the Wasatch Division, has been appointed general manager of the combined facilities. John Higginson, formerly manager of the Utah Division, has been named manager of finance and administration for the unified operations.

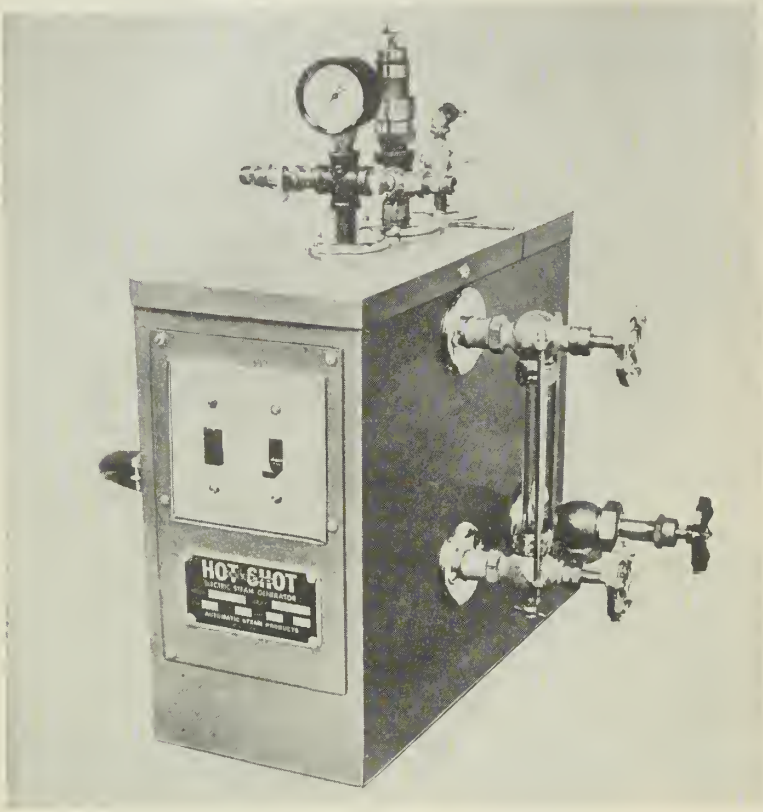
RADIATION TECHNOLOGY, INC., of Atlanta, will begin production on a number of all-transistorized instruments on June 1. The new firm is headed by James T. Bracken, formerly with Lockheed's Georgia Division.

CBS LABORATORIES has consolidated its activities in solid-state physics and promoted Dr. Wolfgang W. Gaertner to Vice President in charge of this area. The new Solid State Branch includes Semiconductor Research and Development, Surface Physics, and Memories and Subsystems.

BORG-WARNER CONTROLS has expanded its Meteorology/Oceanography operations based in Santa Barbara, Calif., adding several research and engineering specialists and additional facilities.

CHANCE VOUGHT CORP.'S new $3.5-million facility of the Electronics Division was officially opened recently. The 80,000-sq.-ft. building will house a completely autonomous electronics organization.


Research
And
Engineering
For
MAN IN SPACE
M/R's special issue covering the research and engineering phase of Man in Space is extremely important and timely... will be read and re-read by M/R's space-oriented audience of over 31,555* paid subscribers.
*Subject to audit.
MISSILES AND ROCKETS
MAY 29, 1961
Final Closing Date May 15
Materials
Boosters
Electronics
Space Medicine
Re-entry



Electronic Component Steam Cleaner

A completely automatic miniature electric boiler designed to be used in steam-cleaning small electronic components and assemblies is available from Automatic Steam Products Corp. The boiler fills a need where ultrahigh-quality steam is required to clean sensitive materials, or where components must be completely free of ferrous contamination.

All units are built to ASME specifications. Models are being used with regular tap water supply or with distilled water, depending on application.

Various horsepower models start at ⅓ BPH sizes and operational ranges are adjustable 0-100 PSI. The smaller units weigh less than 50 lbs., are completely portable and can be strategically placed in almost any part of the plant.

Circle No. 225 on Subscriber Service Card

Ceramic Diode Closure

A ceramic diode closure which meets the hermetic requirements of MIL specifications, and is suitable for thermal cycling between −65° and 150°C, is available in both standard and special sizes from Metalizing Industries, Inc.

The ceramic diode closure consists of a metalized ceramic shell, with a band of metal fired on to the inner edge at each end. The ceramic is L5 steatite. Two end caps are also supplied with each ceramic shell. The end cap is a nickel-iron-cobalt alloy .015 in. thick, clad with .003-in.-thick 60/40 solder.

Circle No. 226 on Subscriber Service Card

Damped Terminal

A lightweight terminal for mounting electronic components at high production rates is available from Pacific Coast Electronics Corp.

The Tri-El terminal is a formed stamping that mounts to a terminal board with a simple staking tool. In contract to ordinary two-element feed-through terminals, the Tri-El unit provides one connection on the top of the board, and two below. The availability of three connection points allows much greater flexibility. The terminal itself, since it is not a rigid post, will absorb vibration forces, greatly reducing the possibility of component failures.

The terminal exceeds requirements for vibration stability outlined in MIL specifications. Under test, a finished terminal board was checked in excess of 30 g's at frequencies from 5 to 2000 cps without showing any connection failure between terminals and components, or terminals and board.

Circle No. 227 on Subscriber Service Card

120° Aerial Mapping System

A 120° mapping projector is available from Bausch & Lomb, which plans to market it at about one-third the cost of comparable foreign-made instruments. In addition, the Balplex 120 is completely portable, for use either in headquarters or mobile field units, and has highest-quality precision optics protected by durable mountings.

The 120° aerial camera lens, developed in Europe, has made it possible to obtain greater area coverage in a single photo taken from the survey aircraft, cutting down on the number of flights over a particular region. In a similar fashion, the Balplex projectors allow mapping organizations to produce topographical maps from the aerial pictures with increased accuracy, economy of processing and field coverage.

Circle No. 228 on Subscriber Service Card

Beacon Transponder

An advanced C-band beacon transponder which increases the reliability of radar tracking systems is available from Military Products Division of General Dynamics/Electronics.

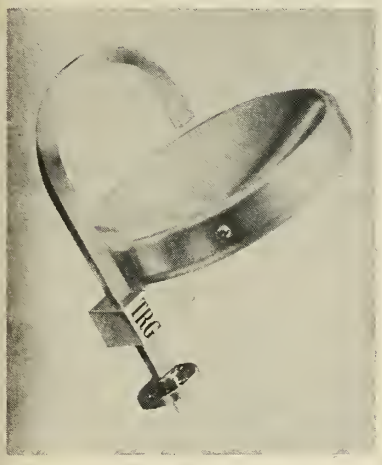
Designed as a tracking aid for missile and high-speed aircraft applications, the transponder (Model SC-702) operates in the 5400-5900 megacycle frequency band, and responds to coded interrogations from radar such as the AN/FPS-16 and the AN/MPS-26. It can decode 38 different codes.

Circle No. 229 on Subscriber Service Card



Parabolic Antenna

Technical Research Group, Inc., Antenna & Microwave Dept., has available a 3-in.-diameter complete parabolic antenna for millimeter bands. The



antenna is available in V, E and F bands.

The miniature antenna has a 4.0° beam width at 70 KMC. This resolution is comparable to that of a 30-in. antenna at 7 KMC. The antenna is further rated at 22 db maximum side lobe; 32.9 db gain; 1 in. focal length. The antenna is designed for millimeter systems and antenna test applications.

Circle No. 230 on Subscriber Service Card

Traveling Wave Tube

A lightweight, compact, low-noise traveling wave tube featuring periodic permanent-magnet focusing is available from General Electric's Power Tube Department for operation in the 7000- to 11,000 megacycle frequency range.

The tube, type Z-3088, is suited for use as an input tube in airborne radar receivers and as a power amplifier in cascade chains.

The Z-3088 has a noise figure less than 15 db., with a minimum gain of 35 db., and minimum power output of 5 milliwatts over its designed frequency range.

Metal-ceramic construction gives the tube the ruggedness needed to withstand severe environmental conditions. The focusing magnets are temperature-compensated, and from —70° to 150° the change in magnetic field is less than 3%.

Circle No. 231 on Subscriber Service Card

Component Test System

A system that can accomplish production line or depot maintenance testing of electronic systems and components for about one-quarter the normal cost is available from Ortronix, Inc.

Designated the "Adept 400", the test equipment is a tape-programed unit capable of maintenance analysis and calibration of complete electronic systems and components. The unit permits automatic test by punch paper commands. It combines general testing capabilities with flexibility and can be custom-modified to fit any purpose desired.

Circle No. 232 on Subscriber Service Card

Directional Couplers

Sanders Associates, Inc. has introduced a line of precision made TRI-PLATE vairable directional couplers for strip transmission line circuits with coupling as tight as 2 db's. The devices, which have broadband applications, can perform as adjustable directional couplers, power dividers or variable attenuators with controllable power handling capacity and wide attenuation range. Within each frequency band three models are available with coupling at 3, 8, or 40 db.

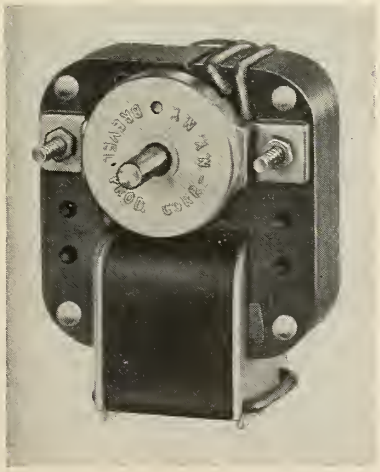
Circle No. 233 on Subscriber Service Card

Induction Motors

Die-cast bearing brackets, with projections anchored in the field laminations, maintain rotor alignment during heavy shock in the Series M Shaded Pole Induction Motors available from Brevel Products Corp.

Used alone or as the backbone of a geared motor, the Series M is available in 4-stack thickness from 0.35 to 1.1 in., with maximum continuous duty torque ratings from 018 to 3 in.-oz. at 120 volts (1.3 to 11.5 in.-oz. during intermittent duty). No-load speed is approximately 3350 rpm.

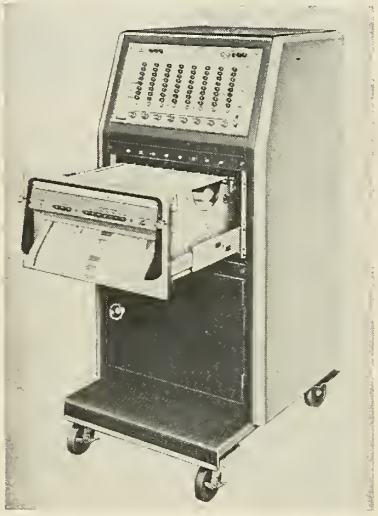
Circle No. 234 on Subscriber Service Card



Accurate Writing Recorder

An 8-channel direct writing system, Recorder Mark 200, produces chart records of an accuracy and clarity never previously achieved by the direct writing method, according to its manufacturer, Brush Instruments, division of Clevite Corp. The unit is designed for use with analog computers but is equally suitable for general multichannel recording requirements.

Recording features include static and



dynamic accuracy of 0.5%, complete absence of overshoots, error-free rectilinear presentation, and a uniform nominal trace-width of 0.010 at all writing velocities.

Circle No. 235 on Subscriber Service Card

Magnetic Mixing Concentrate

A family of materials for the wet method of visible and fluorescent magnetic particle-testing is available from Magnaflux Corp.

The concentrates are all in powder form and incorporate features superior to the previous Magnaflux and Magnaglo pastes, including easier mixing, handling and storage; a measurable increase in fluorescent brilliance from 70% to 600%; closely controlled particle size range; less foaming, and more corrosion protection. The complete family consists of eight different materials.

Circle No. 236 on Subscriber Service Card

Transistorized Signal Tracer

In the absence of an oscilloscope, any low-level microwatt audio and modulated radio frequency signal can be detected or demodulated, then highly

amplified (approximately 1000 times) and reproduced through a high-quality earphone device at the output stage with a stethotracer available from Don Bosco Electronics.

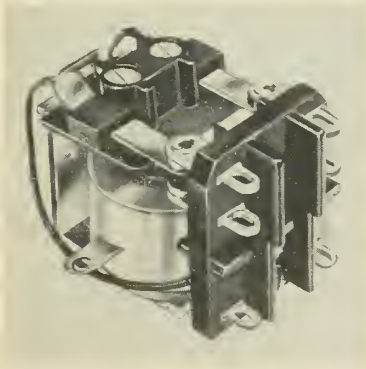
It enables all general-purpose laboratory oscilloscopes and instruments to detect low-level signals in the microwatt region. The output of the stethotracer is plugged into the scope by means of a specially designed adaptor plug (available optionally). The equivalent terminated impedance of the adaptor plug is 600 ohms; it will fit most of the laboratory scopes.

Circle No. 237 on Subscriber Service Card

Beryllia Heat Sinks Now Available Off-the-Shelf

Transistor dielectric heat sinks are available from National Beryllia Corp. Used to insulate semiconductor devices from the chasis, these heat sinks utilize beryllium oxide's ability to resist the flow of electricity but not the flow of heat, allowing higher power without exceeding temperature limits. Previously available only in small quantities made to order, Berlox beryllium oxide dielectric heat sinks are now available for immediate delivery from stock, at prices associated with high-quantity production.

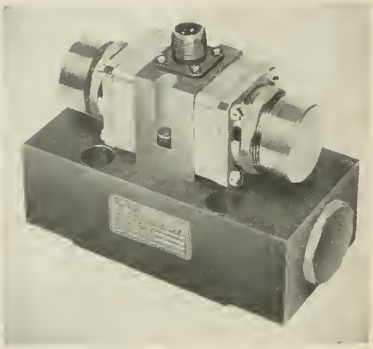
Circle No. 238 on Subscriber Service Card



Low Loss Relay

Artisan Electronics Corp. has available a ruggedized general-purpose relay, Model RF. The relay utilizes diallyl phthalate molded-plastic insulation that maintains insulating qualities and dimensional stability under severe environmental conditions. Thus, the RF Relay is dependable for general purposes and ideal for switching high-frequency current. The unit is compact in design, lightweight and economical.

Circle No. 239 on Subscriber Service Card



GSE Hydraulic Valve

A solenoid-operated hydraulic valve for ground support equipment or other critical control applications, which operates on both 115 volts a-c and 28 volts d-c without adjustment or coil changes, is available from Parker Aircraft Co. The high-performance valve permits operation on regular 60-cycle line current, and on emergency or portable battery power at a cost as low as single-voltage valves.

The valve assembly utilizes a solenoid-operated pilot valve and a heavy-duty slave valve designed for subplate mounting. Various flow sizes are available, depending upon the slave unit specified. All components are designed for operation at nominal system pressures up to 5000 psi, and have a life in excess of 5,000,000 cycles.

Circle No. 240 on Subscriber Service Card

Fiber Optic Printing

Direct optical printing at high speed on film and other types of light-sensitive materials is the result of a cathode ray tube utilizing fiber optic principles developed by Litton Industries.

The E1E11 is a miniature precision cathode ray tube with a face panel composed of a precision array of fiber optic light pipes. The individual light pipes are coated on the vacuum side with phosphor, which is excited by an electron beam emanating from a precision electron gun contained in the tube. By the use of digital deflection voltages a digital code can be generated in the face of this cathode ray tube.

Because the fiber optic light pipes conduct the light from the phosphor to the atmospheric side of the face plate without dispersion, the recording media can be placed immediately adjacent to the face of the cathode ray tube where the information is recorded without use of supplementary optical systems.

Circle No. 241 on Subscriber Service Card

Crystal Filters

Collins Radio Co. has available a line of crystal filters for a broad range of applications in single sideband.

Crystal Filters over the 10 kc to 30 mc frequency range are now being produced in quantities. One of the new units is a 5 mc filter in a thumbsize ⅜ in.^{3} case, less than half the package size previously available.

Circle No. 242 on Subscriber Service Card

Commutating Switches

A series of mechanical commutating switches known as the Deltaswitch Model 210 are available in one-pole and multi-pole configurations for communication of 64, and 100 channels of information from American Standard Corp. Designed for 20 cycles per second operation, these switches are available with or without 1200 rpm, 115 VAC, 60 cycle synchronous hysteresis drive motors.

A jet of mercury replacing the conventional wiper arm for commutation



assures long, trouble-free life and low maintenance expense, thus making Deltaswitch ideally suited to 24 hour per day—continuous operation. After commutating signals for well over 1000 hours, the Model 210 Deltaswitch is restored to like new condition by simply cleaning the switch parts and replacing the mercury.

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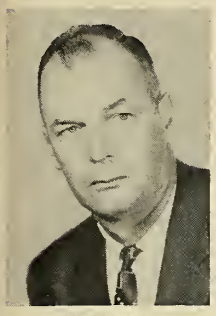
Power Transmission Duct

A high-frequency bus duct, for transmitting electrical power in frequencies from 180 to 20,000 cycles, is available from the Standard Control Division of Westinghouse Electric Corp.

With its use, a central powerplant can service an entire plant, with no need for small, individual high-frequency generators. Voltage drop is less than 1 volt per 100 feet at 400 cycles, based on an equally distributed load, line to neutral value, at the most unfavorable power factor.

Circle No. 244 on Subscriber Service Card

names in the news


KRAYBILL


BEAM


BEGOVICH


CATALDO


WICKHAM

Walter C. Scott: Appointed head of space power technology projects, Office of Space Flight Programs, National Aeronautics and Space Administration, Washington, D.C. Previously Scott was project engineer for the power system of the *Transit* navigation satellite, Applied Physics Laboratory, Johns Hopkins University, Silver Spring, Md.

D. W. Kraybill: Former chief manufacturing engineer for the Astronautics Division, Chance Vought Corp., Dallas, appointed *Saturn* project manager.

William F. Mulcahy: Appointed director of manufacturing at National Semiconductor Corp., Danbury, Conn. Mulcahy formerly was with Hamilton-Standard Division of United Aircraft and RCA's Missiles and Surface Radar Division.

David H. Baker: Former president of Capital Airlines, Inc., elected vice president of Vickers Incorporated, Division of Sperry Rand Corp., Detroit, and general manager of its International Division.

Matthew J. Donachie: President, Metals Research and Manufacturing Co., Holyoke, Mass., elected to the board of directors of Beryllium International, Inc., Washington, D.C.

R. L. Beam: Elected executive vice president of Hazeltine Corp., Little Neck, N.Y. Beam also is a director of Hazeltine and executive vice president and operating head of the company's Electronics Division.

Dr. S. Fred Singer: Named a member of the board of directors of the Decker Corp., Bala Cynwyd, Pa. Dr. Singer, internationally-known astrophysicist, is professor of physics at the University of Maryland and a consultant to the government on space and missile programs.

Daniel E. Chaifetz: Vice president of Tech-Ohm Electronics, Inc., Long Island City, N.Y., elected president and chief executive officer.

Dr. J. Robert Downing: Former president of Space Recovery Systems, Inc., joins Standard Kollsman Industries, Inc., New York City, as technical director of advanced development at its Kollsman Instrument subsidiary. **Louis E. Sharpe** named associate technical director.

Dr. Donald B. Mackay: With North American Aviation's Space and Information Systems Division, awarded the Society of Automotive Engineers' Manly Memorial Medal for presenting 1960's best paper involving aerospace engine system.

Ernest D. Brockett: President of Gulf Oil Corp., elected to the board of directors, Westinghouse Electric Corporation, Pittsburgh.

Dr. Nicholas A. Begovich: Assistant manager of Hughes ground systems group and director of product line operations in Fullerton, Calif., appointed a vice president of Hughes Aircraft Co., Culver City.

Dr. Wolfgang W. Gaertner: Promoted to vice president in charge of solid-state physics, CBS Laboratories, Stamford, Conn. Formerly Dr. Gaertner was chief scientist of the Solid State Devices Division, U.S. Army Research and Development Laboratory, Fort Monmouth, N.J.

Alvin M. Weinberg: Director of Oak Ridge National Laboratory, elected a member of the Physics Section of the National Academy of Sciences.

John G. Sinclair, Jr.: Joins Microwave Laboratories, Quantatron, Inc., Santa Monica, Calif., as senior engineer. Prior to joining Quantatron, Sinclair was with Hughes Nuclear Electronics Laboratory.

Ronald Hendricks: Named manager of systems engineering at Link Division of General Precision, Inc., Binghamton, N.Y. Previously Hendricks was associated with General Electric's *Nimbus* satellite program.

Frederick E. Hines: Former vice president-finance of Douglas Aircraft Company, elected to the Electronic Engineering Company of California board of directors.

Carl J. Stauff: Appointed director of field engineering for Photo-Optical Division of Consolidated Systems Corp., Monrovia, Calif. Stauff previously was director of government sales at Bell & Howell Co.

Stuart M. Hauser: Former chief engineer, named assistant general manager for operations of Electro-Optical Instruments, Inc., Pasadena, Calif.

M. W. Medley: Named chief contract negotiator for Product and Industrial Engineering Corp., subsidiary of Space-Tone Electronics Corp., Washington, D.C. Prior to joining PIECO, Medley was sales engineer for Vitro Engineering Co., New York City.

J. T. Cataldo: Corporate vice president of International Rectifier Corp., El Segundo, Calif., appointed executive vice president and general manager of the company's subsidiary, Dallons Laboratories, Inc., Los Angeles.

Dr. Cameron Knox: Appointed corporate director of research for Acoustica Associates, Inc., Los Angeles. Previously Dr. Knox served as colonel with the Joint Chiefs of Staff, Washington, D.C.

C. S. Brown: Named division manager of newly formed Missile Plastic Division of H. I. Thompson Fiber Glass Co., San Rafael and Inglewood, Calif. **Don Hatch** named technical engineering consultant.

Dr. Donald Wickham: Formerly with Lincoln Laboratory, Massachusetts Institute of Technology, appointed manager, Material Research and Development, Ampex Computer Products Co., Components Division, Culver City, Calif.

Thomas I. Harkins: Promoted to manager of purchasing and contracts for Sylvania Electronic Systems, Waltham, Mass.

Marjorie R. Hyslop: Appointed manager of the American Society for Metals Documentation Service. Previously Mrs. Hyslop was managing editor of *Metal Progress*. Other ASM appointments are: **Taylor Lyman,** editor of reference publication, and **Dr. Allen Gray,** editor of periodical publications.

NASA

$4,800,000—**Aetron, Covina, Calif., Division of Aerojet-General,** for final design of *Saturn* static test facility and procurement and fabrication of technical systems and instrumentation for the facility.

$97,631—**Systems Division of Beckman Instruments, Inc.,** Anaheim, Calif., for design, development and fabrication of Doppler data acquisition and processing equipment.

$41,956—**The Budd Co., Space Atomics Division,** Philadelphia, for pressure vessels for Lewis Research Center.

United Technology Corp., Sunnyvale, Calif., for design, fabrication and test-firing of a flight-weight conical, segmented, solid-propellant rocket motor of 250,000 lbs. thrust. No amount disclosed.

MISCELLANEOUS

$54,288—**Drexel Dynamics Corp.,** Philadelphia, for Aero 16B missile skids.

Capehart Corp., Richmond Hill, N. Y., from **United Aircraft Corp.,** Windsor Locks, Conn., for evaluation of radio frequency interference at proposed missile components test site. No amount disclosed

NAVY

$4,500,000—**General Electric Ordnance Dept.,** Pittsfield, Mass., for Mark 1 inertial guidance systems for the *Polaris* missile.

$2,500,000—**Philadelphia Gear Corp.,** King of Prussia, Pa., from **General Dynamic's Electric Boat Division,** for gear drives for the 600-ft. radio telescope at Sugar Grove, W. Va.

$1,000,000—**Electronic Specialty Co.,** Stamford, Conn., for ASW sonar high-voltage rotating power supplies.

$296,000—**Computer Systems, Inc.,** Monmouth Junction, N. J., for four 5800 Dystac iterative analog computers to aid in design and development of high-speed hydrofoils.

$125,000—**Automation Industries, Inc.,** Manhattan Beach, Calif., from **Hercules Powder Co.,** for study and development of new ultrasonic methods of inspecting an entire solid-propellant missile system.

$100,000—**Electronic Specialty Co.,** Stamford, Conn., for equipment to be used in electronic checkout system for the *Polaris* missile submarine program.

$99,349—**Lockheed Aircraft's Missile and Space Division,** Sunnyvale, Calif., for study of the effects of ultrahigh nuclear detonations.

$85,294—**Vought Electronics Division of Chance Vought Corp.,** Arlington, Tex., for C-band radar beacon, superhetrodyne.

$82,283—**Beech Aircraft Corp.,** Wichita, Kan., for spare parts, materials, and equipment for target drones.

Associated Testing Laboratories, Inc., Wayne, N. J., for reliability evaluation testing of components of the *Polaris* missile. No amount disclosed

ARMY

$2,500,000—**Collins Radio Co.'s Alpha Corp.,** Dallas, for modification of Signal Corps tracking station at Richardson, Tex.

$1,900,000—**Radioplane Division of Northrop Corp.,** Van Nuys, Calif., for target missile production, flight services and engineering services. (Three contracts).

$1,636,395—**Douglas Aircraft Co., Inc.,** Santa Monica, Calif., for guided missile trailers; $84,676 for *Nike* missile system spare parts and launching area items.

$1,162,253—**Philco Corp.,** Philadelphia, for fuzes for the *Sergeant* missile.

$485,799—**McCulloch Corp.,** Los Angeles, for target missile engines and engineering services. (Two contracts).

$437,969—**Western Electric Co.,** New York City, for *Nike-Hercules* warhead body assembly kits with shipping containers (Two contracts).

$305,272—**Berkeley Pump Co.,** Berkeley, Calif., for pumps for *Titan II* missile launch facilities.

$201,854—**Greer Hydraulics, Inc.,** Los Angeles, for hydraulic components for blast doors and blast dampers with auxiliary equipment for *Titan II* missile launch facilities.

$117,280—**Gilfillan Brothers, Inc.,** Los Angeles, for *Corporal* missile spare parts and telemetry equipment.

$96,589—**Worthington Corp.,** Los Angeles, for air compressors for *Titan II* missile launch facilities.

$92,377—**Darco Industries, Inc.,** El Segundo, Calif., for entrapment television system for *Titan II* missile launch facilities.

$89,435—**Associated Aero Science Laboratories,** Hawthorne, Calif., for technical instructions at Redstone Arsenal.

$76,661—**Monsanto Research Corp.,** Everett, Mass., for a study on anti-radiation drugs.

$65,338—**Quinco Electric Co., Inc.,** Orlando, Fla., for construction of instrumentation sites for Complex 34, Cape Canaveral Missile Test Annex, Patrick AFB.

$54,458—**Consolidated Western Steel,** Los Angeles, for *Nike* missile repair parts.

$39,295—**Fenwal, Inc.,** Ashland, Mass., for fire detectors for *Titan II* missile launch facilities.

AIR FORCE

$9,000,000—**The Hallicrafters Co.,** Chicago, for logistic support items for airborne electronic countermeasure equipments.

$1,500,000—**North American Aviation, Inc., Space & Information Systems Div.,** Downey, Calif., for *Hound Dog* mobile training unit trainers.

$1,300,000—**Electronic Communications, Inc.,** St. Petersburg, Fla. for aerospace-ground equipment for *ALRI,* the airborne extension of *SAGE.*

$974,233—**Page Communications Engineers, Inc.,** Washington, D.C., for modification of communications systems. (Two contracts.)

$822,098—**Radiation at Stanford,** Palo Alto, Calif., for design, development, construction, installation and testing of radar communication transmitter.

$750,000—**Royal Industries, Inc.,** Los Angeles, from **Hughes Aircraft Co.,** for specialized containers for the *Falcon* missile.

$728,983—**Hughes Aircraft Co.,** Fullerton, Calif., for radar tracking station.

$600,000—**American Electronics, Inc.,** Los Angeles, from **Boeing Airplane Co.,** for power units for *Minuteman* ICBM, $160,000 from **Boeing** for constant voltage type power supplies for *Minuteman.*

$250,000—**Servo Corp of America,** Hicksville, N.Y., for development of specialized multichannel radio receiver for Cape Canaveral tracking station.

$188,340—**Boeing Airplane Co., Aero-Space Div.,** Seattle, for helium tank assemblies for *Bomarc* weapon system.

$137,105—**Convair (Astronautics) Div., General Dynamics,** San Diego, for seven Azusa transponders and checkout sets.

$99,528—**Hughes Aircraft Co.,** Culver City, Calif., for research in the application of new techniques applicable to recognition of non-cooperative aerospace vehicles.

Electro Development Corp., Seattle, from **Aero-Space Division of Boeing Airplane Co.,** for separation sensing devices for the *Minuteman* ICBM. No amount disclosed.

Spacelabs, Inc., Van Nuys, Calif., for design of a system for continuously measuring space crewmember blood pressure. No amount disclosed.

REQUESTS

The NASA Procurement Office, Marshall Space Flight Center, Huntsville, Ala., has issued a request for Proposal TP 82-227, for 105-in. Oxidizer Containers for the S1 Stage of *Saturn.* The quantity is six each.

The procurement involves extensive facilities (i.e., Hydrostatic Test Arrangement, Cleaning Equipment, Mechanical and Chemical Milling, and welding of sheet aluminum into 105-in. diameter segments).

The units are flight components for *Saturn* booster and rigid reliability, quality assurance, testing and processing specifications are applied. These 105-in. oxidizer containers are cylindrical in shape, have rigid-wall-type structural design, and consist primarily of welded skin segments. spin-forged heads, longerons, stiffeners, manifolds, angles, tubing, and baffles.

The containers are 105 inches inside diameter, approximately 675 inches long, and weigh approximately 6272.776 pounds each. The milled skin segments are fabricated from Type 5456-H343 Aluminum Alloy Sheets, thickness 0.249 to 0.305 inches (unmilled).

Tooling and production layout must be ready by Jan. 1, 1962, with container deliveries commencing Apr. 1962. Proposals are due to be received at the NASA Procurement Office, George C. Marshall Space Flight Center, Huntsville, Ala. (Attn: M-P&C-C), by June 1, 1961.

The following firms have been invited to participate at conference and proposed for prime contract—Boeing Airplane Co., Aero-Space Div., Seattle, Wash.—Chance Vought Corp., Vought Astronautics Div., Dallas, Tex.—Chrysler Corp., Missile Div., Detroit, Mich.—Douglas Aircraft Co., Inc., Santa Monica, Calif.—Lockheed Aircraft Co., Georgia Div., Marietta, Ga.—The Martin Co., Baltimore, Md.—McDonnell Aircraft Corp., St. Louis, Mo.—North American Aviation, Inc., Missile Div., Downey, Calif.

NASA suggests that small business firms or others interested in subcontracting opportunities on this procurement make direct contact with the above firms.

when and where

MAY

National Aeronautical Electronics Conference, IRE, Miami and Biltmore Hotels, Dayton, Ohio, May 8-10.

Fifteenth Annual Power Sources Conference, sponsored by U.S. Army Signal Research and Development Laboratory, Shelbourne Hotel, Atlantic City, N.J., May 9-11.

Western Joint Computer Conference, American Institute of Electrical Engineers, Institute of Radio Engineers, and Association for Computing Machinery, Ambassador Hotel, Los Angeles, May 9-11.

Society for Experimental Stress Analysis, Benjamin Franklin Hotel, Philadelphia, May 10-12.

National Armed Forces Day Dinner, sponsored by Navy League, The Military Order of the World Wars, and the Air Force Association, Sheraton Park Hotel, Washington, D.C., May 12.

British Interplanetary Society, Symposium on Communications Satellites, London, May 12.

Institute of Radio Engineers, Professional Group on Microwave Theory and Techniques, National Symposium, Sheraton Park Hotel, Washington, D.C., May 15-17.

Society of Aeronautical Weight Engineers, National Conference, Sheraton Hotel, Akron, Ohio, May 15-18.

ARS National Telemetering Conference, Sheraton Towers Hotel, Chicago, May 22-24.

Fifth Global Communication Symposium (Globecom V) and National Telemetering Conference, sponsored by American Institute of Electrical Engineers, Institute of Radio Engineers, Institute of the Aerospace Science and Instrument Society of America, Sherman Hotel, Chicago, May 22-24.

Design Engineering Show, Cobo Hall, Detroit, May 22-25.

Society of Automotive Engineers, Military Ground Support Equipment Committee, Continental Hilton Hotel, Mexico City, Mexico, May 23-25.

Operations Research Society of America, Ninth Annual Meeting, Sheraton-Blackstone Hotel, Chicago, May 25-26.

Chemical Institute of Canada, Forty-fourth Annual Meeting, Ottawa, Canada, May 29-31.

7th Annual Radar Symposium (SECRET), University of Michigan, Institute of Science and Technology, Ann Arbor, May 31-June 2.

JUNE

National Machine Tool Builders' Association, 59th Spring Meeting, Mayflower Hotel, Washington, D.C., June 1.

American Society for Quality Control, Annual Convention, Sheraton Hotel, Philadelphia, June 5-7.

International Instrument Automation Conference and Exhibit, Instrument Society of America, Royal York Hotel, Toronto, Canada, June 5-8.

National Electrical Manufacturers Association, Western Conference, Biltmore Hotel, Los Angeles, June 8-9.

Manufacturing Chemists Association, 89th Annual Meeting, The Greenbrier, White Sulphur Springs, W. Va., June 8-10.

European Federation of Chemical Engineering, Thirtieth Meeting, Frankfurt-am-Main, Germany, June 9-17.

American Society of Mechanical Engineers, Statler-Hilton Hotel, Los Angeles, June 11-15.

Third National Symposium on Radio Engineers, Inc., Sheraton Park Hotel, Washington, D.C., June 12-13.

Instrument Society of America, 3rd International Symposium on Gas Chromatography, Michigan State University, East Lansing, June 13-16.

Joint ARS-ISA Meeting, Ambassador Hotel, Los Angeles, June 13-16.

Applied Mechanics Conference, American Society of Mechanical Engineers, Illinois Institute of Technology, Chicago, June 14-16.

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editorial . . .

The Debacle at Cape Canaveral

WE MUST CONFESS that the tremendous publicity buildup for the suborbital *Mercury* shot left us cold, a condition marked by a shiver at the spectre of failure which hovered all too close in the background.

With a courageous astronaut risking his life for what in final analysis had become a circus stunt, the sight of unknowledgeable television announcers assuring the American public that this was a "great day in American history," a day the first American was to "go into space," was nauseous.

On one network show, the announcer asked his blonde colleague what she thought of this great day in American history and was rewarded with several inane remarks, followed by a dogfood commercial.

This is not to question the courage and dedication of the Project *Mercury* team, the technical achievements of the program or the genuine accomplishments of the contractors involved. It is to question the wisdom of the public relations approach to the shot.

To permit the effort to be turned into a Roman spectacle was at the very least in the worst possible taste—and at most an appalling display of ignorance of its effect on world opinion.

Scheduling of the shot was an effort to beat the Russians to manned space flight, although it appeared to us from the beginning to be more of an altitude record attempt than any significant space accomplishment. With Soviet Maj. Gagarin's accomplishment of a true orbital flight, the suborbital *Mercury* shot lost any propaganda value it may initially have had. With so little to gain from a scientific standpoint, it should have been scrubbed. This lack of significance was buried in an emotional frenzy.

Throughout last week's countdown, there persisted the boyhood memory of the "Human Cannónball" in the circus, waiting to be fired out of the big gun and across the arena into a net before the eyes of horrified paying customers. Aside from altitude, the objective was similar and the atmosphere the same. Hurry, hurry, hurry, the big show is about to start.

THE BLAME for this debacle of second-bestmanship rests squarely on the Kennedy Administration.

We are not alone in this belief. Sen. Williams of Delaware told the Senate last Monday, the day before the shot was postponed for the first time:

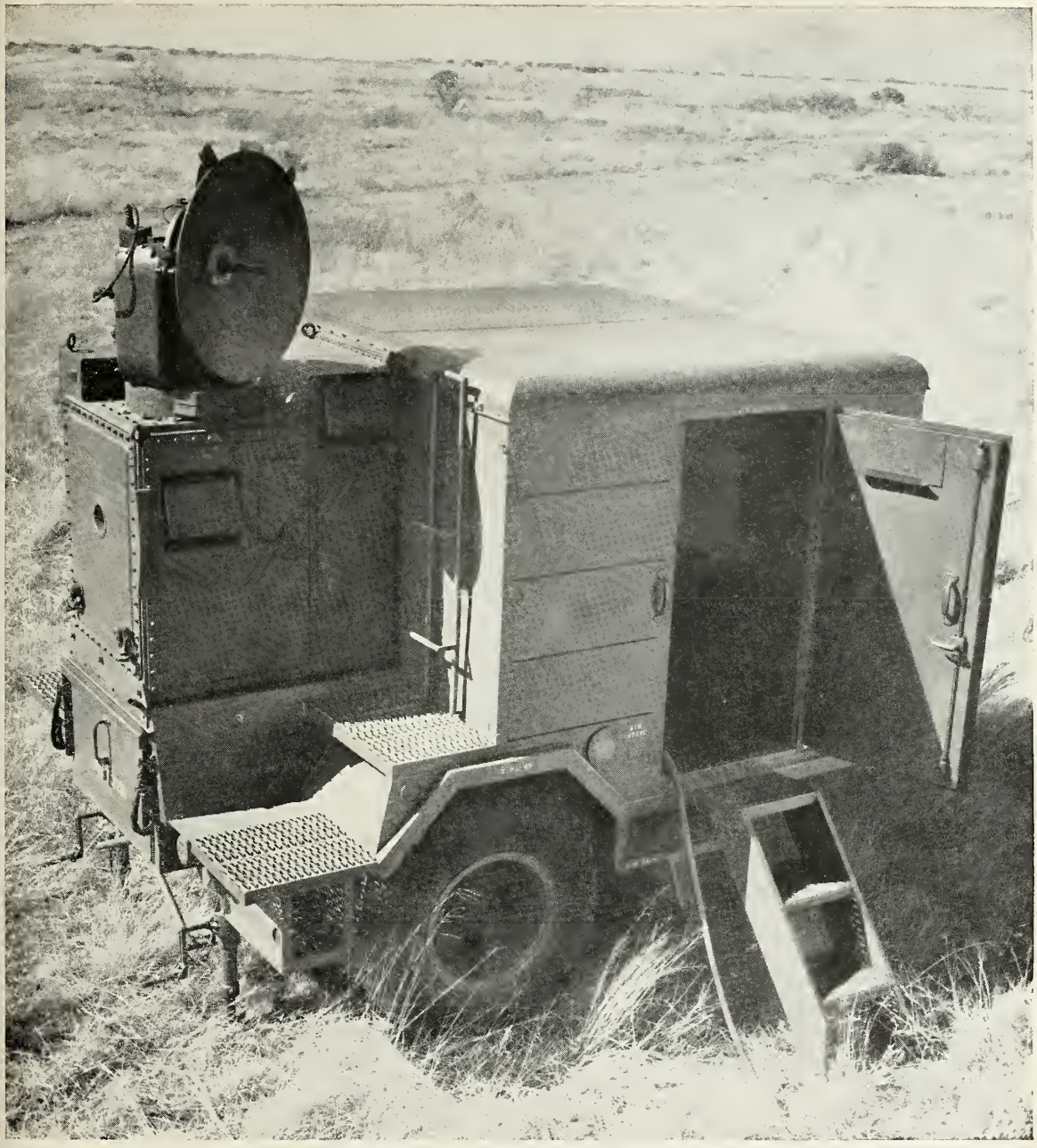
"Administration officials responsible for this project are so confident of its success that they have spent the last 10 days in announcing to the world what a great achievement they expect to accomplish this week at Cape Canaveral. Approximately 500 reporters and photographers from all over the world have been invited there to witness the success of the first Yank-in-space project. I fail to find where any thought has been given to what effect this tremendous buildup will have upon the American prestige should the attempt be a failure."

Sen. Williams said he had suggested to the Administration that it cancel the suborbital shot and reschedule it for a future, undisclosed date. He added: "Then when this project is rescheduled, it should refrain from any publicity until after it has actually been attempted."

To anyone familiar with missiles, this made good sense. It is now too late to do anything about the suborbital shot. But we suggest the Administration study carefully what has taken place and begin planning now to avoid its recurrence in connection with the orbital *Mercury* shot.

We are not suggesting the orbital shot be closed to the press. But a great deal can be done to eliminate the revolting display to which we were treated last week.

William J. Coughlin



The pilot is inside, flying over enemy lines.

The SD-1 Surveillance Drone flies remotely controlled tactical surveillance missions without risking manned aircraft or pilot. It is extremely mobile, simple to use and maintain, and can be readily adapted to carry TV or film cameras, infrared, radiation detection or radar reconnaissance equipment. The SD-1 is the Army's only operational surveillance drone. Northrop's Radioplane Division developed and produces it.



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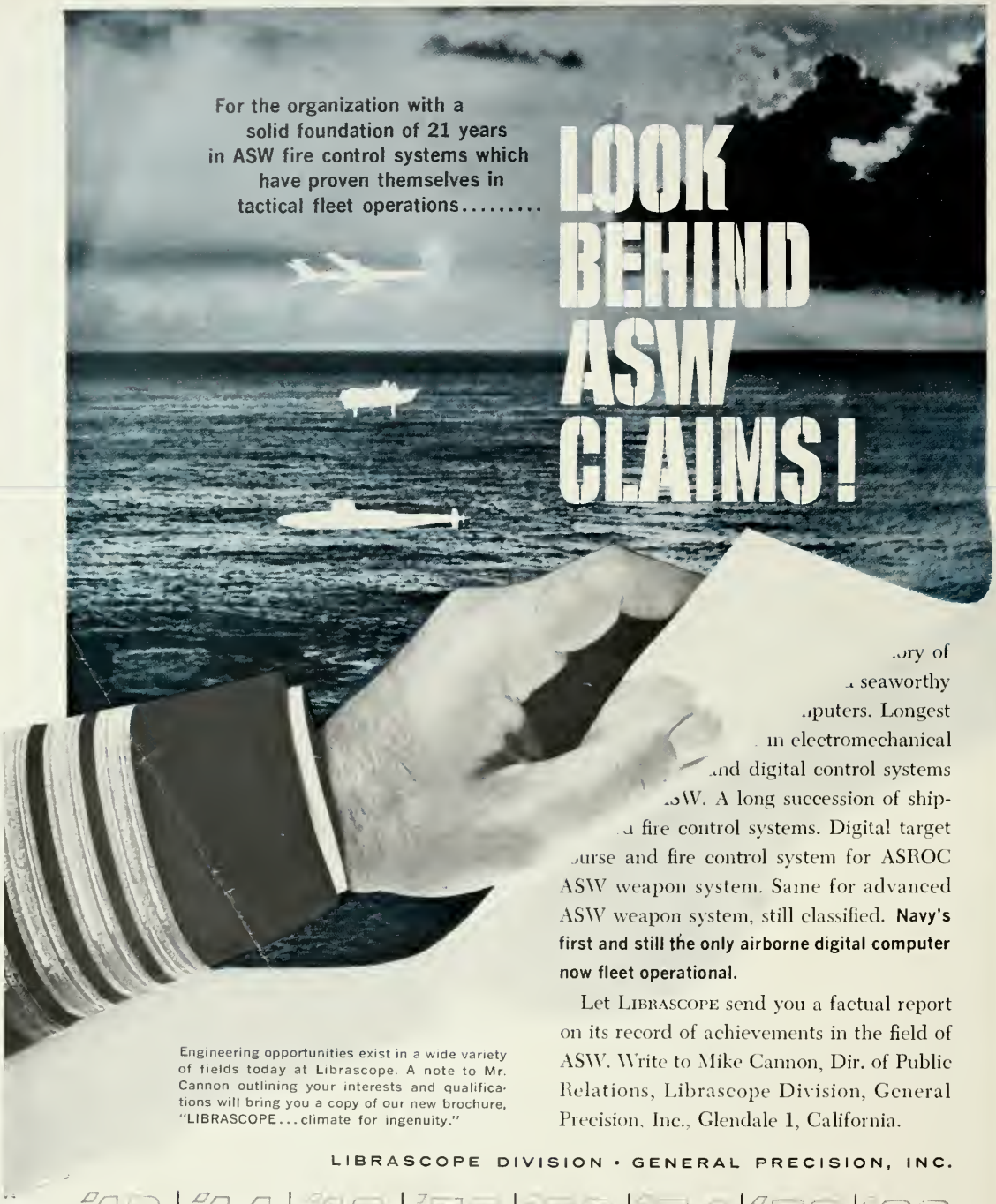
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THE MISSILE / SPACE WEEKLY

missiles and rockets

Volume 8, Number 20 May 15, 1961

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THE COVER

Cmdr. Alan B. Shepard studies instruments in his capsule during historic May 5 flight of Mercury Redstone 3. NASA photo is one of sequence taken at rate of four per second.



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ENGINEERS



Explorer VII

HOW FAR INTO THE SPACE AGE WILL YOUR PRESENT POSITION TAKE YOU ?

We're living in the space age, an era of accelerating technology in which engineering techniques, equipments and materials can become obsolete over-night. For this reason many engineers are today working in areas where the prospects for long-term professional growth are highly questionable.

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letters

Rebuttal for ABMA

To the Editor:

I realize that you don't want the debate to be interminable, but I think it unfair to leave Mr. Frank Cameron's letter regarding the twist collimator (M/R, April 17, p. 9), and his comments regarding ABMA, without some rebuttal.

We can all acknowledge the fine work being done by Dr. J. G. Gievers with polarized light in alignment of inertial platforms, but I know that Dr. Gievers and the men at Chrysler would be the last to state that there was a lack of interest in such devices at ABMA. My employer, The Perkin-Elmer Corporation, has been making phased-light, closed-loop optical alignment systems for ABMA and Chrysler since 1957 for use on the *Jupiter* program. Further, these systems, used in conjunction with the ABMA-spawned ST 90 platform and the other components made under the close technical guidance of the very capable group at ABMA, have achieved records of accuracy which, while classified, are, I think, without equal.

In our files are letters from Mr. Walter Haeussermann dating back to 1956 expressing interest in the phased-light alignment devices, and our initial contract for the development of the *Jupiter* Electro-theodolite received in June 1957.

(Cameron's letter) also implied a lack of competence on the part of the group in the Guidance and Control Lab at ABMA, since it was stated that they didn't . . . understand the (Gievers) system well enough to push its application for the *Redstone* and *Jupiter* missile systems." Knowing Dr. Gievers, I'm sure he was as shocked as we were at this statement. There was simply no group in the country which was more technically competent than were the men in the G & C Lab. You have only to ask yourself who put the first U.S. satellite in orbit and with what missile.

Joseph C. Dixon
Ridgefield, Conn.

Gremlin Department

To the Editor:

The editorial in M/R, March 13, refers to the fact that "On Aug. 19, man for the first time recovered an object from orbit, the capsule from *Discoverer XIII*."

On page 19, reference is made to the "Recovery of the first object from space with the successful retrieval of the *Discoverer XIII* capsule on Aug. 11, 1960."

It was my understanding that the capsule from *Discoverer XIII* was picked up out of the water on Aug. 11, 1960 and the capsule from *Discoverer XIV* was recovered from the air on Aug. 19, 1960.

It is not the intention of this letter to point out a slip in editing, nor in any way to belittle the very fine job that Lockheed Missiles and Space Division have done. Rather, it is to point up the contribution that Small Business, as represented by All American Engineering Company, made in

this instance by providing some of the equipment which made the program possible. The recovery equipment in the aircraft, including the trapeze-like structure suspended from the fuselage of the C-119, was designed, developed, tested and manufactured by All American *as a system.*

In addition, USAF crews were trained in the operation and maintenance of the equipment by All American, including the establishment of pilot and flight techniques.

Sometimes part of the story is overlooked; it occurred to me that you might welcome this type of comment.

Charles W. Wendt
President
All American Engineering Co.
Wilmington, Del.

Reader Wendt is correct in pointing out M/R's typographical discrepancies with respect to Discoverers XIII and XIV. Adding to the confusion, the page 19 story also said that the Polaris sub George Washington sailed from Charleston on Nov. 16. The editorial reported (correctly) that she sailed on Nov. 15.—Ed.

Viewport Clarification

To the Editor:

We certainly are pleased with your article, "AF Presses Work on Vehicle Windows" (M/R, April 3, p. 22). It is an excellent, comprehensive report on work in this field.

You stated correctly that Corning recommends multiple-glazing systems. The question is: How many glazings? I think it might be helpful to add that we believe any number of panels more than five is exorbitant, because of problems of optics and weight that arise. If five glazings won't do the job, then we recommend use of metal shields that can slide over the viewports when needed, as you reported.

Somewhere along the line we might have left the impression that we invariably recommend resilient cushioning in the area of contact between glass and metal. This isn't an invariable recommendation. When appreciable temperatures are to be encountered, the flow of heat to and from the glass through the frame should not be impeded by a gasketing material that acts as an insulator, as any resilient material certainly would do.

Arthur F. Shoemaker
Product Development Coordinator
Aircraft and Missiles Group
New Products Division
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Corning, N.Y.

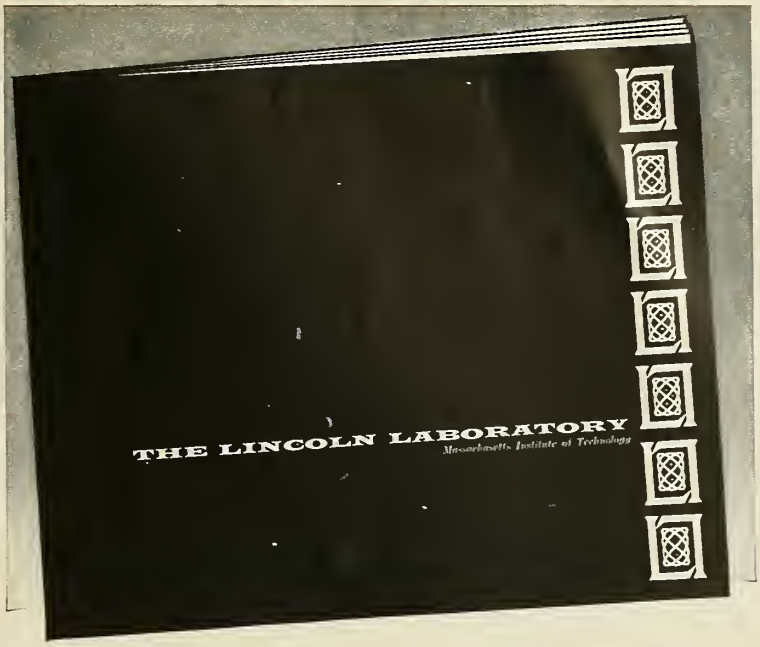
It's More or Less SOP

To the Editor:

M/R is a VFP and I would read more issues CTC if I didn't have to spend SMT trying to figure out WTH all the code letters mean.

D. L. Holbrook
The Fafnir Bearing Co.
Los Angeles

Most such CL's are either thought to be well known (TWK?) or spelled out higher up in the stories. Try putting "magneto-hydrodynamics" in a headline.—Ed.



The Lincoln Laboratory, Massachusetts Institute of Technology, announces a major expansion in its program. We urgently request the participation of senior members of the scientific community in our programs in:

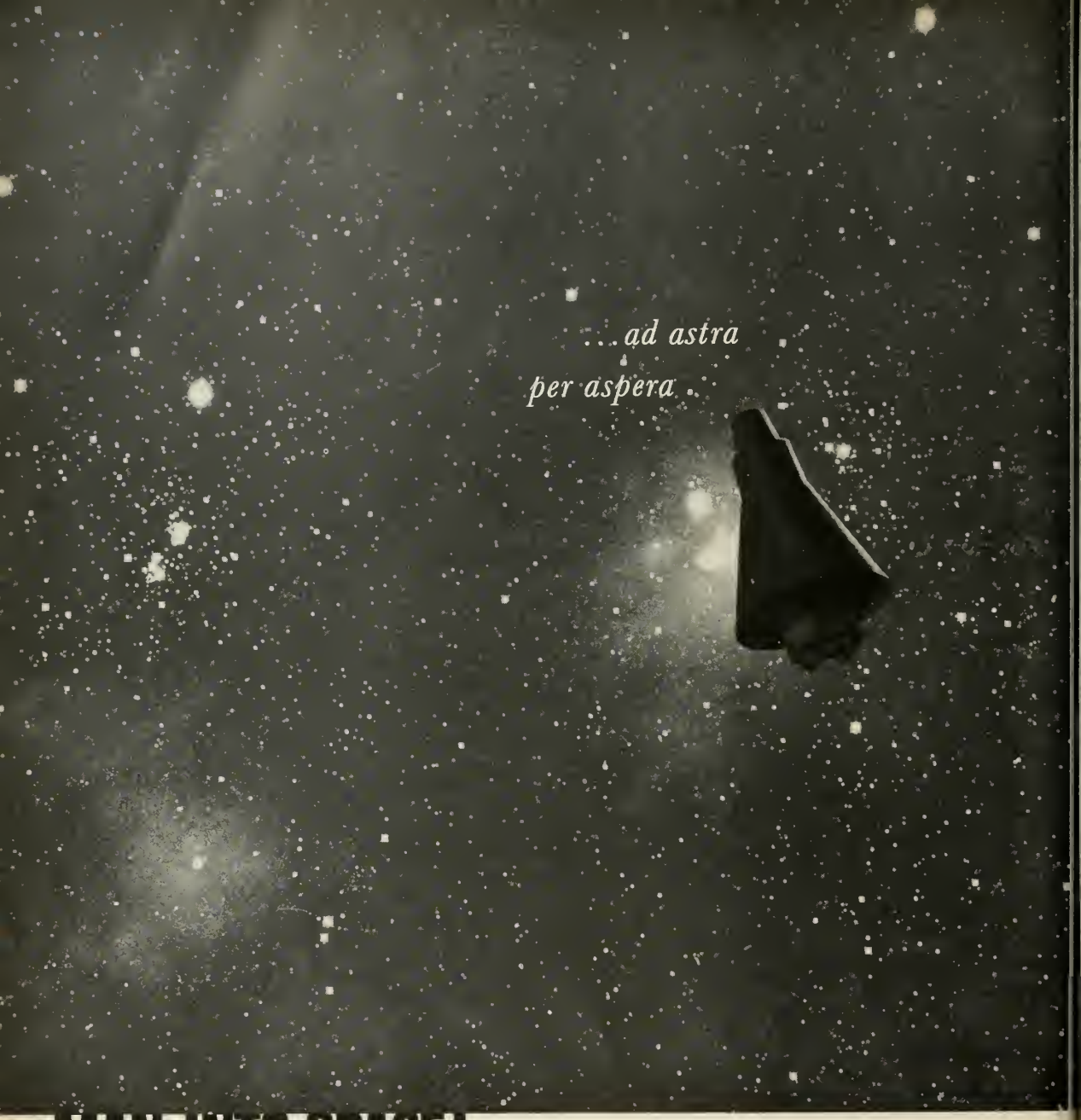
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The Countdown

WASHINGTON

Will JFK Commit Himself to Space?

Adding more dollars to FY '62 space budgets now will answer a current political demand. But the question being asked in many top offices is whether the President will commit himself to an all-out space race with Russia. Part of the question will be answered by the way the President places the new dollars—whether they merely bolster what the U.S. is doing or whether they underwrite an all-out program with a directive to move. Part of the answer must wait until the FY '63 budget is released.

Atlas Failures at Vandenberg?

There is strong evidence that the Air Force may have tried secretly to salvo two or more *Atlas E* operational models at Vandenberg and failed. This much is certain: Four early *Atlas E's* launched at least in a series took a considerable time to get off their pads. Also they apparently were wide of their targets. Difficulties were caused by different problems. The shots were unannounced.

Early Titan Deployment May Be Slipping

The next underground *Titan* shot from Vandenberg will be from an elevator silo—the first test launching of this type in the program. Meantime, plans to deploy the first operational *Titan I's* in elevator silos at Lowry AFB this June may have slipped by several months. The Air Force now is talking about obtaining an "emergency combat capability" for *Titan* "later this year." All 12 *Titan* squadrons are expected to be deployed by the end of calendar 1963—exactly one year after all 13 *Atlas* squadrons are due to be deployed.

Missiles Help Save Bombers

The Douglas *Skybolt* was one of the principal reasons the Senate Armed Services Committee approved an extra $525 million to keep the Air Force's jet bomber production lines going. Many members of the committee feared that in the late 60's the Air Force would run out of enough B-52's for *Skybolts* unless more were built.

Subroc to Join The Fleet

The first *Subrocs* are still expected to be deployed with the fleet this year, along with their nuclear warheads. Later models of the Goodyear sub-launched ASW missile will have a dual capability so that they can be fitted with conventional warheads in homing torpedoes. Previously, there were some reports that the first *Subrocs* would be deployed in the first part of 1961.

INDUSTRY

NASA Readies Big Solid Competition

Within a week or two of getting word that the Administration and Congress will approve it, NASA plans to call a bidders' conference on a big solid-rocket R&D competition. Time in this case could be first consideration, money second. The program will be under control of the Marshall Space Flight Center.

47 Targets for Zeus

General Electric's MSVD will develop and produce 47 target-warheads to be launched by *Atlas* and *Titan* missiles against the Army's *Nike-Zeus* A-ICBM. Key provision in the $10-million contract calls for simulating "various combinations of known re-entry vehicle threats" —decoys and multiple warheads. Target-warheads will have miss-distance indicators. Army already has ordered 18 *Atlases* (to be launched by SAC crews from Vandenberg) for the tests now scheduled to start in January.

R&D Intelligence

Follow-on contract of $35.8 million goes to Philco Corp. for continued development of command and control subsystems for the Air Force *Discoverer, Midas* and other space programs. . . . Aerojet-General has test-fired successfully a 25-ton, 2-segment solid rocket developing 160,000 lbs. thrust, biggest of its type. . . . Balloon system for recovering missile equipment at Mach 10 and up to 155,000 ft. altitude (Goodyear's "Ballute") will be tested soon at Holloman AFB and Eglin AFB.

Inside Track for Chrysler?

Redstone's performance in the *MR-3* manned suborbital flight is expected to improve Chrysler's standing in the competition for the *Saturn S-II* stage R&D contract. NASA's Marshall Space Flight Center is known to be leaning toward Chrysler on the basis of its previous *Redstone* and *Jupiter* work.

INTERNATIONAL

Polaris Offer to NATO Renewed

More as a reminder to Russia than anything else, the United States is renewing its offer to give NATO five *Polaris* subs (80 missiles). The subs would still remain under American control—just a different U.S. commander.

Russian Bead on the Moon

A French science writer back from Moscow says the Russians will put a 7-to-8-ton "permanent research station" on the moon by the end of the year. He says they will use a rocket weighing 600 to 700 tons which will be tested this summer. . . . In the U.S., informed observers tell COUNTDOWN the Russians might land a man on the moon in 1963—without trying to bring him back immediately. Object: to lay claim to the moon. Comments one scientist: "Men have sacrificed their lives for far less in the past."

Overseas Pipeline

British are rather disturbed over a U.S. offer to provide some boosters to the European Space Club. It could kill chances for a *Blue Streak*-based space industry in Britain. . . . *Skylark* rockets launched from Woomera will attempt to take ultraviolet photos of the stars under a program financed by the Royal Observatory, Edinburgh. . . . The Italian Air Force is ordering Sispre *C-7* air-to-air missiles into production. . . . There are rumors the Russians may fly a high-powered ion engine by 1964.

GD Takes to the West

General Dynamics Corp. is shifting operating headquarters for 75% of its business from New York City to San Diego.

The move is part of the reshuffle which eliminates Convair as a division of the company. The enlarged San Diego office will direct the activities of G-D/Astronautics, G-D/Fort Worth, G-D/Pomona, G-D/San Diego, G-D/Daingerfield, and G-D/General Atomic.

C. Rhoades MacBride, previously Convair acting president, will head the West Coast operation. Convair executive vice president August C. Esenwein is reported to have resigned as a result of the corporate structure change.

Army Confirms Entac Choice

The Army has made official its decision to buy the French-designed *Entac* antitank guided missile.

The wire-guided missile weighs 27 pounds, is solid-fueled and carries a conventional warhead. Details of the procurement program have not yet been announced.

Radio Interference Center

A tri-service facility aimed at analyzing and controlling radio interference here and abroad will be getting technical support from the Armour Research Foundation of Illinois Institute of Technology under a $2-million contract awarded by the Electronics Systems Div. of the Air Force Systems Command.

Called the Electromagnetic Compatability Analysis Facility, it will have temporary headquarters at ARF, where methods for processing and analyzing radio interference problems will be developed. Later, the center will move to a permanent facility located at the U.S. Naval Engineering Experiment Station, Annapolis, Md.

Disarmament Comes First

No secret-sharing or cooperation on cosmic flights can be expected from the Soviets until the disarmament problem is solved.



Army's M-55 Chemical Rocket

NORRIS-THERMADOR CORP. engineer demonstrates angle of launch for Army's M-55 chemical rocket. The solid-fueled rocket actually is fired in salvos of 45 from battlefield position. Stabilizing fins, folded to fit in fiberglass shipping-launching tubes, open automatically when the rocket is fired. M-55's are deployed with Army Chemical Corps troops in U.S. and overseas.

Soviet scientist Leonid Sedov indicated in a *Pravda* article that a "favorable development of international relations" would also be necessary.

Sedov's statement appeared partly to refer to the Kennedy-sponsored proposals for some kind of joint Russian-American space venture.

Pluto Reactor Test Due

The Atomic Energy Commission late last week scheduled the first power run of the Tory II A-1 reactor for the Pluto nuclear ramjet.

The first run, at a reported level of 40 thermal megawatts, was the beginning of a series intended to demonstrate the feasibility of the system at levels up to 150 thermal megawatts.

Pluto is the propulsion system intended for the *SLAM (Supersonic Low Altitude Missile),* an Air Force weapon aimed at coming in under enemy radar to avoid detection.

Shots of the Week

At the Cape: An Air Force *Blue Scout* rocket carrying almost 400 lbs. of radiation sensing equipment and instrumentation swerved out of control soon after launch and was destroyed. The shot, first failure in six for the *Blue Scout,* would have taken it 1000 miles into space.

The Navy scored a "100% success" on a land-pad firing of an advanced *Polaris* missile. The 1600-mile flight proved out components of the improved guidance system.

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A half-billion to start . . .

Big Space Spending Increase Studied

PRESIDENT KENNEDY this week considered plans that would give the nation's space program possibly more than a half-billion-dollar shot in the arm.

If approved by the White House and Congress, the increases could open the way for a multi-billion annual effort over the next decade.

Division of the proposed increases: From $300 million to $500 million for NASA, from $90 million to $150 million for the Air Force.

Moreover, the White House was expected:

—To ask Congress for some additional money for AEC space work.

—Possibly to authorize the Air Force now or within the next few months to spend FY '62 money already requested at a faster rate. The difference would then be made up in a supplemental request in January.

• **"Earth can be dominated"**—As the President weighed various proposals for a speed-up, the Senate Armed Services Committee released grim, secret Air Force testimony on the Soviet military threat in space.

Air Force Secretary Eugene M. Zuckert told the committee on April 11: "The United States and the Free World must insure that the means of earth domination inherent in space mastery be not pre-empted by the enemies of freedom. . . . The lesson is that through and from space, earth can be dominated."

Gen. Thomas White, Air Force Chief of Staff, told the committee the same morning: "It is particularly significant that Soviet efforts in the military exploitation of space have an extremely high priority. Apart from their lunar probes of 1959 and their recent probe directed at Venus, Soviet exploration of space has been concentrated on the near earth region—the logical area for the near-term expansion of military aerospace power.

"For example . . . (security deletion) . . . the Soviets could launch a large space platform—truly a major rung in the ladder of the achievement of effective space weapon systems. There also are many indications that they may put a man in space in the very near future."

Soviet Cosmonaut Yuri Gagarin was launched into orbit the following day.

• **Where it may go**—The lowest public estimate on how much more money would be requested for space programs by Kennedy came from Sen. Robert S. Kerr (D-Okla.), chairman of the Senate Space Committee. He estimated a 20-to-25% increase over the $1.2 billion budget originally proposed for NASA by the Kennedy Administration.

However, informed sources put the NASA figure closer to $500 million. They also said the Air Force would receive about $100 million to possibly $150 million and additional funding would go to the AEC.

One usually informed source put the figures flatly at: $509 million for NASA and $91 million for the Air Force.

It was not immediately clear where the White House planned to spend the additional money. However, propulsion and man-in-space projects were considered to be the most likely areas.

NASA and AEC's *Rover*, the nuclear-powered rocket engine, might receive $50 million or more to speed the R&D program and possibly begin a second approach. NASA's *Apollo* program might receive as much as $75 million in an attempt to launch a three-man spacecraft into orbit by early 1965. Both NASA and the Air Force's solid-propulsion studies might receive a total of from $25 to $50 billion. ⌗

Goldberg Ready to Move Against Work Stoppages

THE KENNEDY Administration—needled by fresh exposures of missile base construction mismanagement—is expected finally to take executive action to prevent further delay-causing work stoppages by labor unions.

Labor Secretary Arthur J. Goldberg is exploring some approaches which would require unions to take no-strike pledges. He could:

—Set up a labor-management committee that would take care of jurisdictional disputes and handle questions between missile contractors and unions in the manner of mediation committees which dealt with airline and railroad disputes earlier this year.

—Establish an even more potent nine-man panel similar to the old War Labor Board of World War II.

Meantime, Defense Secretary McNamara has told the Air Force to stiffen its spine in dealing with union demands that have outraged Senate investigators.

The flurry of action, however, was largely a barn-door-closing affair. Most of the damage to the *Atlas* and *Titan* base-building programs occurred in 1959 and 1960 under the Eisenhower Administration, which tacitly refused to use its executive powers to move against wildcat strikes. The most that could be hoped for now was that similar work stoppages could be avoided in the *Minuteman* base-building program.

Strikes at the pads have declined sharply this year—chiefly as a result of improved Air Force-contractor management policies instituted last fall and through pressure exerted by industrial union chiefs on their locals. Figures presented to the Senate's Permanent Investigating Subcommittee showed that 327 strikes occurred at 22 missile bases during the past 4½ years, causing a loss of 162,000 man-days of work. One third of the loss occurred at Capt Canaveral.

There was testimony from B. G. MacNabb, operations chief for General Dynamics/Astronautics at the Cape, that the whole missile and man-in-space program had slipped six months because of low worker production. MacNabb said the trouble was not only attributable to workers seeking to prolong high-paying jobs, but to "lack of decision" by the Government, DOD and "our own management."

Douglas V. Dorman, vice president for industrial relations of The Martin Co., charged the unions with responsibility for delaying both the *Titan* base-building and missile R&D programs. He said union rules against using prefabricated electric cables for GSE are upping the cost of *Titon* squadrons by $3.6 million.

• **Countercharge**—The chief of the AFL-CIO Building Trades Department, C. J. Haggerty, countered that the major delays in the missile base programs were caused—not by organized labor—but by the "inordinate number of (engineering) change orders resulting from the concurrency policy." He said the unions have voluntarily taken action to stop "unauthorized, irresponsible and unjustified" strikes.

Predicting speedy action by President Kennedy, Goldberg refused last week to say whether the man-in-space program had been affected. (NASA officials contend their Mercury schedule, which has slipped repeatedly, has not been hampered by labor troubles.) Goldberg added:

"I don't want to make a scapegoat of anyone. We need a greater sense of urgency on the part of all elements in the missile effort." ⌗

Special Report



MR-3 Proves Man Is Most Reliable Space Machine

Suborbital success wins worldwide applause; second Redstone shot—probably with Glenn—next on schedule

by Jay Holmes

THE MAN performed more reliably than the machines.

This is the technical significance of *Mercury Redstone 3,* America's first space flight, a brief suborbital mission in which Astronaut Alan B. Shepard Jr. flew to an altitude of 115 statute miles and 302 miles down the Atlantic Missile Range from Cape Canaveral.

There were malfunctions in the rocket and the *Mercury* capsule. There were troubles in telemetry, an inverter and in a computer 1000 miles away that delayed the liftoff two hours and 34 minutes from the scheduled time May 5.

But there were no malfunctions in Alan Shepard, a computer of far more advanced design than anything yet developed by science.

Next in Project *Mercury* will be a second manned *Redstone* flight probably near the end of June. The pilot is expected to be John H. Glenn, Shepard's backup.

In the next few weeks NASA also will try once more to inject an unmanned capsule into orbit and recover it after a single cycle. The last attempt with a *Mercury Atlas* failed on April 25.

Shepard's flight scored welcome psychological and political gains for the Kennedy Administration, coming as it did after the orbital flight of Russia's Yuri Gagarin and foreign policy reverses in Cuba and Laos. However, it did not affect the timing of the first U.S. manned orbital flight, which is scheduled for late this year but may still slip into 1962.

• **Publicity payoff**—Conducted in a glaring spotlight of publicity, the shot was a gamble which paid off handsomely. In contrast to the secrecy surrounding the Soviet shot three weeks ago, the United States by its wide open press coverage picked up the plaudits of the free world.

NASA officials—brushing aside pre-launch adjurations against massive publicity—let it be known that all future space launchings will likewise be open to the press.

This will mean a continuation of NASA's policy of extreme caution and step-by-step pace, since every time the U.S. sends a man in space the country's prestige will be riding with him.

The caution showed itself in the long, methodical series of tests that were conducted on the capsule and the *Redstone* rocket. Shepard gave away an open secret when he told a post-flight press conference *Mercury* could have put a man into a suborbital space mission ahead of Gagarin.

NASA Space Task Group chief Robert R. Gilruth certified in March that the capsule was ready and recommended immediate flight. But Dr.

(Continued on page 16)





FLOODLIGHTS cast an eerie glow in pre-dawn darkness as Shepard steps into gantry for ride to Mercury capsule.

Highlights of Shepard's

←

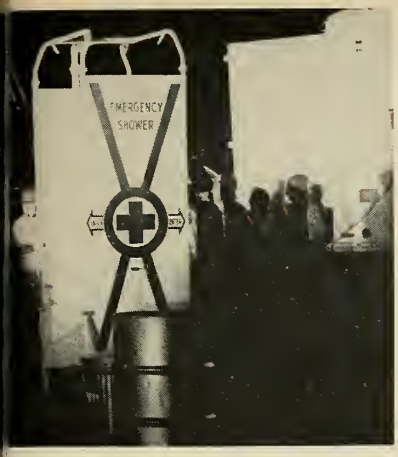
LEFT: Shepard enters gantry carrying his portable air-conditioning unit. He is followed by Mercury Dr. William K. Douglas.

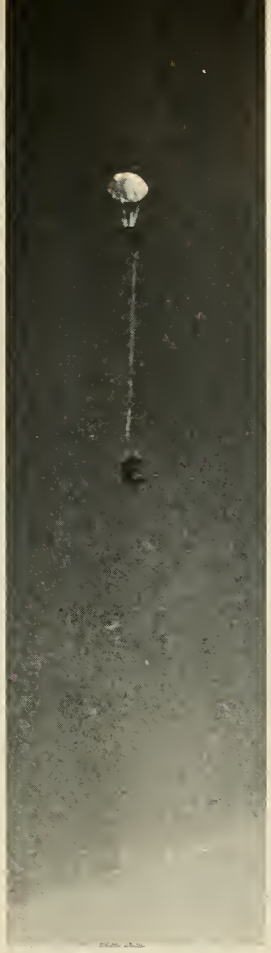
MAY 5, 1961, Alan B. Shepard's big day, began when he was awakened in Hangar S at the north end of Cape Canaveral at 1:30 a.m.

After a shower, breakfast and a medical examination, he began putting his pressure suit on at 3 and at 3:59 Shepard left the hangar to enter a special transfer van, waited there a while and then traveled four miles to Pad 5, about a mile south of the point of the Cape.



COMING UP—Astronaut holds onto line from helicopter as he is hauled from his capsule after 15-min. flight.





LEFT: A view from the capsule as it descended. A small parachute carries the main-chute container away after the chute broke out.



BEAUTIFUL VIEW seen by Shepard through periscope.

Smooth Trip

These pictures show other big moments in the day—entering the gantry, views from the capsule in flight, Shepard climbing into the helicopter that retrieved him, examination by doctors aboard the carrier Lake Champlain, and flight to Grand Bahama Island.

Shepard says he's now ready for orbital flight—when the *Atlas* booster is ready.



PRONOUNCED FIT—Drs. Robert Laning and Jerome Strong examine Shepard aboard aircraft carrier USS Lake Champlain. They found no ill effects.



HAPPY ASTRONAUT laughs during flight from Champlain to Grand Bahama.

(Continued from page 13)

Wernher von Braun, whose Marshall Space Flight Center modified the *Redstone* for the *Mercury* mission, refused to certify that the *Redstone* was ready.

U.S. intelligence had received strong indications in March that Russia was ready for a manned flight. Russia had returned a spacecraft from orbit once on March 12. Nevertheless, the U.S. government approved Von Braun's recommendation of another *Redstone* development flight, which took place March 24. Russia on March 25 repeated its performance of March 12.

Only after the *Redstone* shot was Gilruth given authority to schedule a manned flight. Before doing so, he had to give the three *Redstone* astronauts a series of final centrifuge tests, conduct air-drop tests to prove out the capsule landing bag and check out the capsule escape system with a *Little Joe* flight.

The *Little Joe* flight was necessary because, in a March 18 test of the escape system, the rocket fired prematurely and sequencing of the system was faulty. However, despite the early firing, the system operated under more severe conditions than could be anticipated in a *Redstone*-boosted flight. The repeat firing, which took place April 28, just a week before the manned flight, proved out the system under loading greater than that anticipated for *Atlas*-boosted orbital flight.

• **No Monday quarterbacks**—In a statement at the start of his May 8 press conference, Shepard said the astronauts are "very proud of the manner in which the program was planned from the start, in which certain tendencies to speed up at times because of other events were carefully considered, evaluated, sometimes were taken and sometimes were discarded."

When asked whether the *Redstone* could have flown him ahead of Gagarin, Shepard replied.

"The answer to that is yes. We could have. We could have gone a lot earlier. . . . All of us who are here on the stage now are in—were in and are in—complete agreement with the way this program is laid out. There were times when we could have rushed the program. We chose not to."

Asked why, Shepard said:

"Primarily, because we had a well-laid-out, well-designed, reliable program, and I think possibly you know that we have been, that this view has been substantiated several times by various committees."

Asked whether the approach had been too cautious, Shepard commented:

"Well, it's always easy to look back on Saturday's game on Monday morning. It's very difficult to make decisions ahead of time. I think that Mr. Webb and Mr. Gilruth, as well as I, have been satisfied with the progress of *Mercury*. We have speeded up in areas of which you are not aware, and the general directive was to go when ready, and we did."

What were the technical accomplishments of *MR-3?* The three major test objectives were achieved. They were familiarizing a man with a brief space flight, evaluating his ability to perform useful functions during all phases of the flight, and studying his physiological reaction during the flight.

• **Control not essential**—Shepard passed with flying colors on all three counts. It is true that Yuri Gagarin, by Soviet account, also passed muster on his familiarization, physical reaction and emotional response to a much more rigorous flight. No one in a responsible position in the U.S. government seriously doubts that Gagarin did fly around the earth once April 12.

But the information is of virtually no value to the U.S. or anyone else in the world. Russia has told very little about the design of the rocket, the capsule, the telemetry or the stresses its pilot withstood. If the U.S. is to obtain such information, it will have to obtain the information by its own efforts.

In one minor aspect Shepard's brief flight may have been superior to Gagarin's. Shepard took over pitch, roll and yaw control of the spacecraft attitude, first as an exercise and later to position the craft for retrorocket firing. Gagarin's capsule had manual controls, but the Soviets did not say if he used them.

Gilruth reported that Shepard fired the retros at an attitude within 5° of the angle—blunt end facing 34° above the horizon—required for manual-controlled re-entry from orbit. If he can do anywhere near as well on an actual mission, he will have no trouble getting back from orbit.

The retrofiring and positioning were not essential to the success of the mission. The *Mercury* capsule's aerodynamic stability would have kept in a blunt-end-forward attitude even if Shepard had failed to control it properly.

In addition, an automatic stabilization and control system devised by Minneapolis-Honeywell was available to back up the pilot. Further, some control was possible from the ground.

• **Busy astronaut**—On re-entry from orbit, however, aerodynamic stability is not sufficient because of the intense heat developed. Only the ablation-type re-entry heat shield is capable of withstanding re-entry temperatures. The Haynes Stellite nickel-cobalt afterbody withstands a relatively high temperature—but nothing like re-entry temperature for more than a second or so.

Shepard was a busy man during the 15-min. flight. On liftoff, he reported that the clock had started. A half-minute later, he reported that the control system fuel supply was working, acceleration was 1.2 g's, cabin pressure was 14 psi and the oxygen supply was working. He made four more reports of conditions, including battery potential of 24 volts on the main bus and 29

(Continued on page 43)

Kennedy Rebuttal

(Editor's Note: Last week, MISSILES AND ROCKETS *editorially criticized the Administration for the publicity buildup which turned the suborbital Mercury shot into a circus, pointing out the effect a failure would have had on world opinion as a result. The following transcript is from President Kennedy's May 5 press conference.)*

Q.—Mr. President, were you satisfied with the coverage given today of the space shot . . .?

A.—Well, I agree that if it had failed, having had some experience with that, it would be a very difficult time for NASA and for us all. But fortunately, it succeeded.

I have not got the answer, however, to the question of the buildup. What I think is somewhat unfair is when pressmen themselves—editorial writers—criticize NASA for attempting a big buildup with all of the implications it would have to our prestige and standing if there's a failure.

We are not responsible. At least we're making every effort not to be responsible for encouraging a press concentration of this event, because quite obviously if we fail we're humiliated here and around the world. But in a free society if a newspaperman asks to be represented and to come then he can come.

So I think everybody ought to understand that we're not going to do what the Russians did or be secret and just hailing our successes.

If they like that system they have to take it all, which means that you don't get anything in the paper except what the government wants. But if you don't like that system, and I don't, then you have to take these risks and for people to suggest that it's a publicity circus, when at the very same time they're very insistent that their reporters go down there, does seem to me to be unfair. What is fair is that we all recognize that our failures are going to be publicized as well as our successes and there isn't anything that anyone can do about it or should.

Special Report

Redstone's Years of Frustration



TWO YEARS LATER . . . Wernher von Braun watches in blockhouse at the Cape as Mercury Redstone-3 liftoff approaches.

by James Baar

ONE OF THE most heartbreaking stories of the Missile Age has come to an end and hardly anyone has noticed.

The hero of the story is a 69-foot missile called *Redstone*.

Equal billing goes to the missile's principal creator, Dr. Wernher von Braun.

The official story of *Redstone* begins in 1951 when Von Braun and his mostly German team of rocket engineers and scientists were directed by the Army to begin developing the missile.

Essentially the *Redstone* was an advanced version of the old German *V-2* which Von Braun and his team had built during World War II at the secret rocket center at Pennemünde.

Redstone was a far better missile and could carry much larger warheads. But technically the *V-2* and *Redstone* were very closely related. And both were designed to strike targets at ranges up to about 200 miles.

The test program was a great success. In all of the R&D flights there were only two out-and-out failures. By 1954, Army officials and Von Braun were proposing that *Redstone* be used to launch a small earth satellite. The plan came to be called Project *Orbiter*.

• **Out to pasture**—It was rejected. Instead, the Navy in 1955 won approval of its ill-fated Project *Vanguard* satellite proposal.

The Army persisted. On Sept. 20, 1956, a *Redstone* carrying two solid-propelled upper stages was launched from Cape Canaveral. The missile hurled an 84-lb. payload 3300 miles down the Atlantic Missile Range. If the same multistage missile had been given a fourth stage—as it could have been—a small man-made satellite could have been placed in orbit.

However, *Redstone* scored no points. The Army was ordered not to repeat such flights.

Redstone was put out to pasture in the space race.

Almost precisely one year later—on Oct. 4, 1957—Russia launched *Sputnik I* into orbit and became the first nation to put a man-made satellite into space. *Sputnik I* weighed 184 lbs.

Less than a month later—on Nov. 3—Russia launched *Sputnik II* carrying Laika, the first space dog. *Sputnik II* weighed 1120 lbs.

• **Moment of glory**—During the growing panic at the top levels of the Administration, the Army was asked what it might do. The result was that *Redstone* was recalled from pasture to back up *Vanguard*.

On Dec. 6, a test version of *Vanguard* died in flames a few feet above a Cape Canaveral launching pad. On Jan. 31, 1959, a *Redstone* with three upper stages comprised of solid-propellant rockets roared from the Cape with *Explorer I* on its nose. America's first satellite was in orbit. It weighed 30.8 lbs.

Redstone might have other triumphs, but little could compare with this one. *Explorer I* might have weighed only one-sixth of *Sputnik I*, but all America felt that the nation was back in the space race and Russia could be bested.

It was generally agreed that the next great goal was to put a manned satellite in orbit. Optimism was widespread.

Von Braun and Army officials proposed that as a starter the United States put a manned capsule on top of a *Redstone* and launch it down the Atlantic Missile Range. The capsule would soar to an altitude of about 150 miles. The American inside would experience about six minutes of weightlessness. He would also be the first man in space.

Von Braun testified before Congress in the spring of 1958 that he could launch the first man into space with a *Redstone* within one year "from the word 'go.' "

• **Overruled**—One of the principal opponents of the plan was Dr. Hugh Dryden, then head of the National Advisory Committee for Aeronautics and now Deputy Administrator of NASA. He said such an experiment "is not of very much greater value than the shooting of a lady out of a cannon."

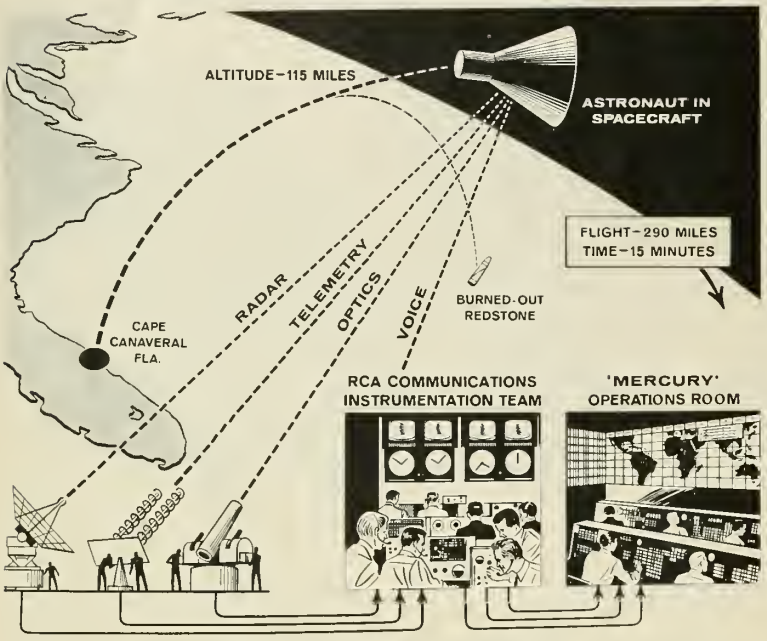
Von Braun told Congress cuttingly: "Some people have taken the position that it would be nothing but a stunt. But we were told the same thing when back in 1954 we first suggested a minimum satellite with the *Redstone* missile."

He also stated at another point that had he been permitted to begin the *Redstone* program in 1946 he could

(Continued on page 44)

Special Report

Communications Troubles Were Few



Project Mercury Communications

OPERATION of the elaborate and complex *Mercury* communications system was "about as expected."

Voice communication between the capsule and ground control was generally satisfactory except for a brief period just prior to re-entry. At this point, capsule acknowledgement of main chute opening was lost in noise. Shortly thereafter, ground communication was shifted to Grand Bahama and remained satisfactory for the rest of the mission.

Ultrahigh-frequency channels were used throughout the flight. Shepard shifted briefly to high-frequency for a checkout, then back to UHF. The point at which communications were lost was at a range of about 300 miles from Canaveral—near the limit for the UHF channel. In an orbital flight, as in the "lob-shot," UHF will be the primary system and HF will serve as back-up.

First reports indicate that telemetered channels were received well throughout the flight. Troubles were encountered with one of the four EKG channels in the original countdown on Tuesday, but this was considered minor and did not hold the launch. Repairs were made during the weather delay and all channels were in operation for the Friday flight.

• **Voice plus telemetry**—*Mercury* communications—one of the most advanced and complex systems ever built to serve one program—includes both voice and telemetering links. Built by Collins Radio, it includes ground-command systems for the sequencing mechanisms, instrumentation telemetry, tracking beacons, voice and home recovery radio. Command receivers in the capsule receive and decode ground command signals to activate various controls signals.

Telemetry transmitters provide ground stations with coded instrumentation information about the capsule and its passenger. Radar transponder beacons on two radar frequencies provide a strong return for ground tracking stations. Recovery beacons, combined in a single unit but operating on two frequencies, assist recovery craft in locating the capsule.

For voice communications, a "switchboard operator" in the control center monitors several radio channels to the astronaut within the capsule and picks the best to feed to another astronaut serving as "capsule communicator" in the operations room. The voice system was checked out in at least two previous missions with tape recorders which transmitted voice tapes back from the capsules to test phonetics and reception.

• **Tracking in reserve**—Only a part of the world-wide network of tracking stations established for the *Mercury Atlas* orbital mission was used for the *Mercury Redstone* flight.

The principal base of the global network at Canaveral is supported by two stations operated by Radio Corporation of America for regular instrumentation and tracking on the Atlantic Missile Range—on Grand Bahama and Grand Turk Island—and by an additional tracking site and control center in Bermuda.

Beyond Bermuda, in mid-Atlantic, a ship with special equipment is used to keep in voice contact with the *Mercury* vehicle as it passes overhead. The ship also has telemetry antennas to receive signals from the capsule and single-sideband radio and teletype links to maintain communications with the rest of the network.

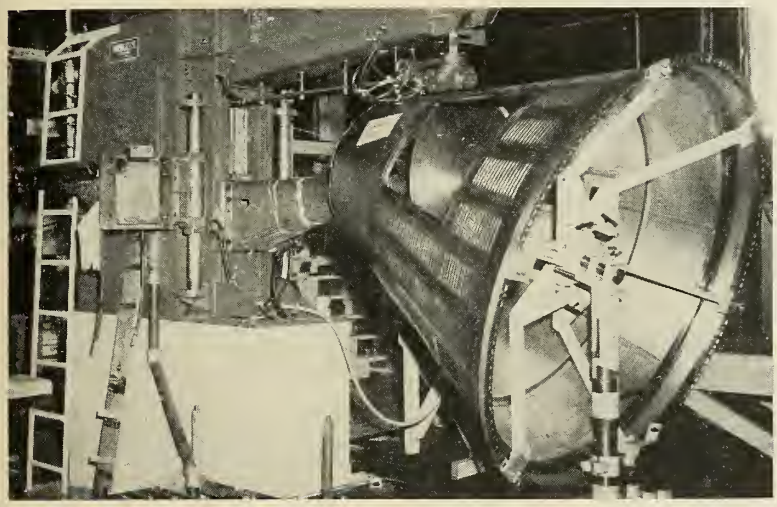
Then, in succession, there are tracking stations with varying equipment at the following locations; Grand Canary Island, off the west coast of Africa; Kano, in Nigeria; Zanzibar, off the east coast of Africa; another ship in the Indian Ocean; two Australian locations at Muchea and Woomera; Canton Island, in the South Pacific; Kauai, in Hawaii; Point Arguello, Calif.; Guayamas, Mexico; White Sands, N.M.; Corpus Christi, Tex.; Eglin AFB, Fla.; and finally NASA's Goddard Space Flight Center, Greenbelt, Md.

In addition to providing voice communications with the capsule, all of the stations except Goddard are equipped either to track the flight or to receive telemetry data on progress of the flight and condition of the capsule and astronaut. Many stations can do both.

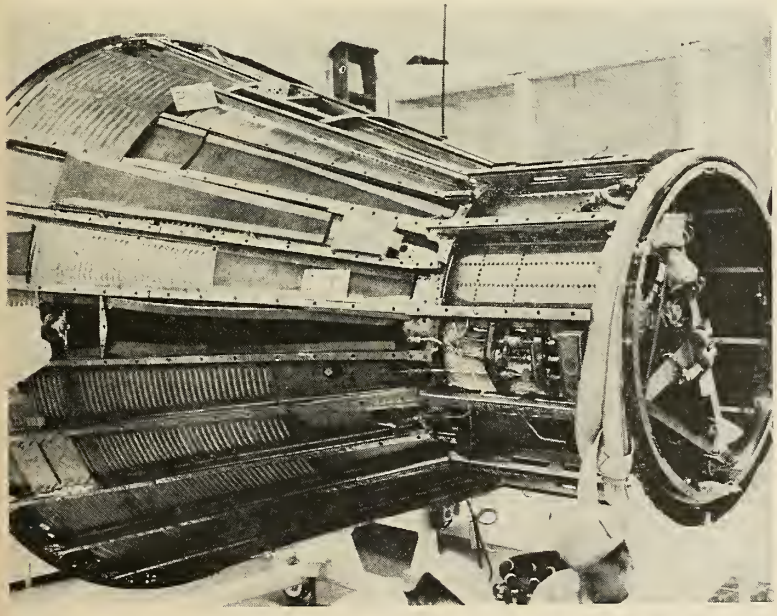
This data is transmitted by standard communications channels—radio, land-line and submarine cable—to the Goddard center. Here the data, already translated automatically into computer language, is processed. From Goddard, the data is flashed to the Canaveral center to be fed into the operations room.

The operations room includes a 40-ft. map of the world, with colored rings indicating the tracking stations and an indicator to show the location of the *Mercury* vehicle at any given moment. ⌗

Materials Met Test All the Way—As Expected



SEAM-WELDING capsule cones follows positioning spot-welding. Approximately 24,500 inches of seam-welding is performed on each Mercury vehicle.



OVERLAPPING EXTERNAL SHINGLES are visible during the fabrication of the Mercury capsule. Min-K insulation is seen along the tops of the ribs. A H_2O_2 thrust chamber is at right center.

STRUCTURAL and protective materials used in the Freedom 7 *Mercury* capsule functioned perfectly—to no one's surprise.

Months and years of painstaking quality control went into every square inch of the capsule. Each component in the structure was thoroughly checked out long before capsule construction, and after.

Thus the *Mercury* capsule does not represent current state of the art in titanium, nickel alloys, heat shields and insulation.

Over 18 months ago the first saucer-shaped beryllium disc was successfully hot-pressed by Brush Beryllium Co. Alcoa used a 50,000-ton press to reduce the billet to an 80-in.-diameter disc, 3 in. thick. Brush then machined the heat shield to its final configuration.

The beryllium shield is being used only on *Redstone* launches. For the *Atlas* orbital shots, an ablative heat heat shield developed by Cincinnati Testing Laboratory will replace it. Exact composition of the ablative shield is classified, but it is known to be a laminated glass-resin structure.

The primary structure of the capsule is fabricated from titanium. The inner skin consists of two layers of 0.010-in. titanium welded together. The 0.020-in. outer titanium skin is corrugated to a rigidity equal to a skin thickness of 0.050 in. Titanium Metals Corp. of America supplied the metal.

McDonnell engineers perfected a method of fusion-welding the thin sheets to titanium structural members, using fixtures that provided inert-gas shielding on both sides of the weld. Weld strengths exceeded base-metal strengths.

Thermal insulation in the capsule involved Johns-Manville Min-K 1301 enclosed in stainless foil and 3 densities of Thermoflex RF felt. Choice of particular insulation depended upon location and anticipated temperatures.

Through thermal paths to the Astronaut's area were eliminated with a combination of Thermoflex on the 24 structural ribs and Min-K at the connecting joints of each rib.

The outside of the capsule is covered with shingles of nickel-cobalt alloys developed by Haynes Stellite Co., Division of Union Carbide. The same alloys have been used in certain supersonic aircraft applications, but the exact nature of its composition is believed classified. Haynes spokesmen say the alloy is easily worked into the required shapes.

Winchester-Western Division of Olin Mathieson developed the explosive bolts used throughout the *Mercury* system, and Artra Aluminum Foundry & Mfg. Co. supplied the casting components.

Freedom 7 had a round glass viewport developed by Corning. Later capsules will use a rectangular port. ⌘



200 miles down the Atlantic Range, General Electric silicone rubber will help keep him afloat

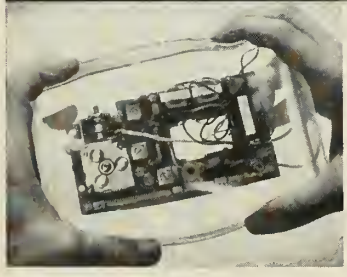


Sixteen and a half minutes after its first manned launching, NASA's blunt-nosed Mercury spacecraft will paradrop into the Atlantic Ocean.

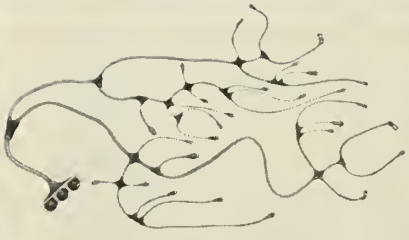
Here it will float like a buoy marker to await recovery. To help protect the first American astronaut, the Mercury spacecraft is completely sealed with General Electric RTV silicone rubber — the new liquid rubber designed to keep the spacecraft air and water tight even after being subjected to the temperature extremes encountered during take-off, flight and re-entry.

McDonnell Aircraft Corporation, prime contractor for the Mercury spacecraft, applies RTV around rivets and bolts wherever structural material, requiring sealing, overlaps or butts together. Able to cure at room temperature, versatile General Electric RTV silicone rubber has found a wide range of uses in missiles and ground support equipment.

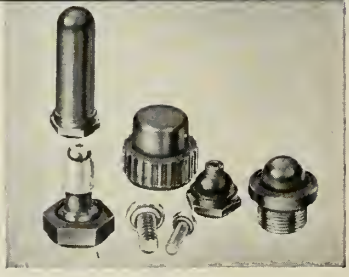
G-E SILICONE RUBBER FINDS MANY USES IN MISSILES AND SPACE VEHICLES



Potting and encapsulating materials protect delicate electronic parts. Clear LTV, shown above, is transparent even in sections several inches thick. RTV liquid silicone rubber encapsulants and clear LTV all exhibit excellent electrical properties, resist shock, vibration, ozone, plus corona and other environmental hazards.



Missile wiring harness, above, is from the Titan propulsion system. G-E silicone rubber wire insulation maintains good electrical properties over wide temperature extremes. Jacketing of high-strength silicone rubber, plus breakouts and junctions molded from RTV were chosen for their insulating properties, resistance to temperature extremes and stability in storage.



Silicone rubber gaskets and seals give long life, heat resistance, and low temperature flexibility in many missiles and space vehicles. Applications range from nose cone gaskets to tiny Seelskrews and Hexseals, by Automatic and Precision Mfg. Company, which combine fasteners with silicone rubber seals for easy assembly.

For full information on General Electric RTV silicone rubber, clear LTV silicone compound, and fabricated silicone rubber parts, write: General Electric Company, Silicone Products Dept., Section 0544, Waterford, New York.

GENERAL ELECTRIC

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Technical Countdown

ASTRONAUTICS

Satellite TV Within Ten Years

Live television broadcasts on a global basis will be a reality within the next decade, says the chief engineer of General Dynamics/Astronautics. He predicts such broadcasts from 24-hour satellites launched by *Atlas-Centaurs*.

Fly Now; Pay Forever

Figured on the basis of current costs, a ticket for an earth-orbit space flight for a 150-lb. man would cost $150,000-$450,000. And the fare would include no baggage and no meals. But an Aerojet-General executive says using recoverable boosters could cut the cost to about $300.

Groundwork Laid for Interstellar Travel

An Interstellar Research Foundation has been organized to "stimulate thought and scientific research" on efficient methods for interstellar travel which would not involve rockets (or similar mass-reaction devices), and for interstellar communications.

Ion Source for Space Engine Operates

A 61-beam ion source being developed for deep-space engines has run for 175 consecutive hours without failure. The Electro-Optical Systems device produced three millipounds of thrust. I_{sp} is around 8000 sec and efficiency about 65%. Goal is to reach this efficiency at lower I_{sp}.

ELECTRONICS

Seismic Instruments Locate Missile Impacts

Army scientists are studying the use of seismic instrumentation for detection and precise location of missile impacts. Feasibility of using existing oil-exploration methods for this purpose will be researched by Dresser Industries/S.I.E. at White Sands Missile Range, N.M.

Big Electronics Market Increase Seen

Military electronics will be a $10.5 billion business by 1970, a General Electric executive predicts. Pointing to a 350% increase in four major electronics categories in the last 10 years, Dr. George Haller said that medical and space electronics will be major factors in the predicted increase.

How Good Is Electronic Cooling Equipment?

Effectiveness of present methods for cooling electronic equipment—and the penalties in size, weight, and power requirements—is being studied for the Navy by Motorola. Primary objective is to establish evaluation techniques and standards to measure thermal design advances.

Lost: One Field Radio

Predicted advances in miniaturization will make the post-1970 soldier's equipment so small that finding it will be his problem rather than carrying it. According to Gen. George Decker, Army Chief of Staff, such advances will eliminate nine-tenths of the soldier's load.

SUPPORT EQUIPMENT

Hercules Sites to Get Hipar Radar

Installation of new high-powered radar is scheduled for *Nike-Hercules* sites in the near future. The GE radar—10 times more effective than present operational equipment—was proved out last year in successful kills of a *Corporal* and two other *Hercules*.

World's Brightest Light Source Developed

A new xenon lamp developed for the Army is two to three times brighter than the sun. The lamp's radiating xenon plasma reaches a temperature of 15,000°F. Described as the world's most powerful, the eight-kilowatt light source is expected to have space and commercial application in addition to military uses.

Range Ship Contracts Still Not Let

The Air Force has still not awarded contracts for instrumentation of two new Atlantic Missile Range MARS ships. Heavy competition for the estimated $50-million job has reportedly narrowed down to about four possible primes. The award—which has to run a gamut of approval through AFSC, AF headquarters, and Gen. Yates' DOD R&E office—will probably come about June 1.

Fuel Cells for Submarines

The Navy is seriously considering fuel cells for submarine propulsion. A current contract ($764,000) with M. W. Kellogg Co. calls for design, development, manufacture, and test of a prototype sodium amalgam-oxygen plant. Informed sources say several other contracts have been let recently or are imminent.

ADVANCED MATERIALS

Vapor System for Storable Fuels

A vapor combustion system that facilitates the handling and loading of storable liquid fuels and eliminates the need for ground disposal has been developed by Avien, Inc. The system has been incorporated into the *Titan II* missile

Ozone Formed by Gamma Radiation

A National Bureau of Standards study into the formation of ozone by gamma radiation in several liquid and solid oxygen mixtures has developed an interesting offshoot—the high amount of ozone formed in liquid nitrogen. The nitrogen is often slightly contaminated with oxygen, and gamma radiation converts a disproportionately high amount of this to ozone. The Bureau says that irradiated nitrogen should not be completely evaporated from its container because of the explosion hazard.

Space Communications Seen by 1965

GE's ComSat proposes 10-satellite system costing about $218 million; conflicting plans likely to be compromised

by William Beller

A SYSTEM of 10 commercial satellites receiving and transmitting communications on a global basis could be operating in 1965.

A demonstration communications satellite could be in orbit in little over a year.

All that is needed for these events is authorization from the Federal Communications Commission. This is the contention of General Electric's newly formed subsidiary, Communication Satellites, Inc. (ComSat).

GE is one of a score of companies responding to an FCC inquiry into the best way to set up a commercial space communications system. Most of the organizations that filed opinions are eager to form a combine of companies and international agencies and to participate in it.

There are individual differences. For example, American Telephone & Telegraph Co. and International Telephone & Telegraph Corp. want the combine to admit only FCC-licensed message-sending interests plus appropriate international agencies, while GE wants the combine opened wider to include the aerospace as well as the entire communications industry (M/R, May 8, p. 16).

These are points of position; they are not rigid and it is expected that they will be modified. Bearing this out, AT&T says that "We are . . . interested in the possibilities of any plan which may show technical and economic promise and which will provide channels suitable for high-quality telephone service."

• **A $200-million network**—ComSat estimates that the cost of its proposed worldwide communications system, consisting of relays in outer space and ground terminals, would be about $218 million. This is based on the system's comprising 10 satellites, and 20 operating and two experimental ground stations.

About $63 million would go for engineering design and development of experimental and final satellites—their radio equipment as well as ground radio equipment. The remaining $115 million would go directly into the operational system, which includes ground terminals, launching operations and booster costs.

• **Global telecommunications**—The satellite system is designed to tie in with all types of domestic and international telecommunications services. These include telephonic, full-duplex and half-duplex telegraphic, facsimile transmission, business machine data, wide-band audio and television relay. It is intended to serve sparsely settled areas as well as heavy traffic paths such as the transatlantic link.

In effect, the system would be a common carrier's common carrier.

To get the needed flexibility, the proposed space system would contain the following types of communications equipment:

—Four radio repeater packages, each able to handle 300 3.6-kc voice channels as a block; or two 24-channel groups and one 252-channel group.

—One radio repeater package able to handle one 6-mc-baseband television signal.

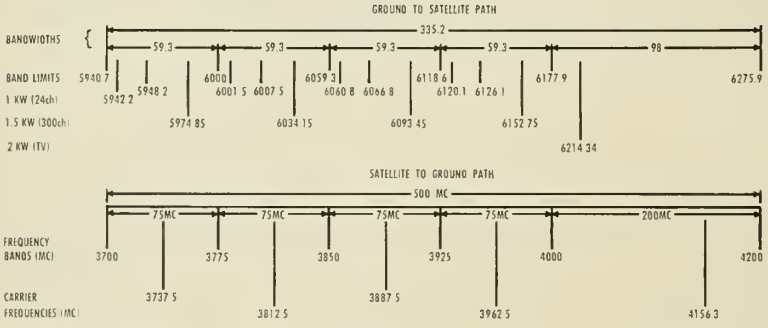
—Two additional repeaters to provide adequate service to low-capacity stations.

Each of the four radio repeater packages would contain a main receiver whose output would be translated into the appropriate frequency and amplified by its associated transmitter.

In addition, two auxiliary receivers —outriggers—would be attached to each main receiver. Each of these outriggers would be able to receive 24 voice channels, demodulate them, and remodulate a subcarrier oscillator in the transmitter for subsequent transmission along with the main bank of channels. In this way, service would be provided to medium-size ground stations in blocks of 24 transmission channels.

• **Ground relay stations**—Fixed ground relay radio stations would be

Requested Frequency Allocation



Proposed Transmitter Characteristics

Type Signal	Path	Transmitter Power (watts)	RF Bandwidth (mc)	Baseband Capacity (mc)
24 voice channels	up	1000	2.6	0.108
300 voice channels	up	1500	17.2	1.3
	down	4	44.5	1.3
TV channel	up	2000	33.1	6.0
	down	15	119.0	6.0

needed to furnish multiple 300-voice channel and TV relay services, and for remote supervision of the satellite radio packages.

The 24-channel transmitters would be time-shared between two frequencies each; thus, four transmitters would be used to check the eight 24-channel satellite receivers. No corresponding 24-channel receivers would be needed for operational purposes, but there would be two spare receivers for developmental and emergency service.

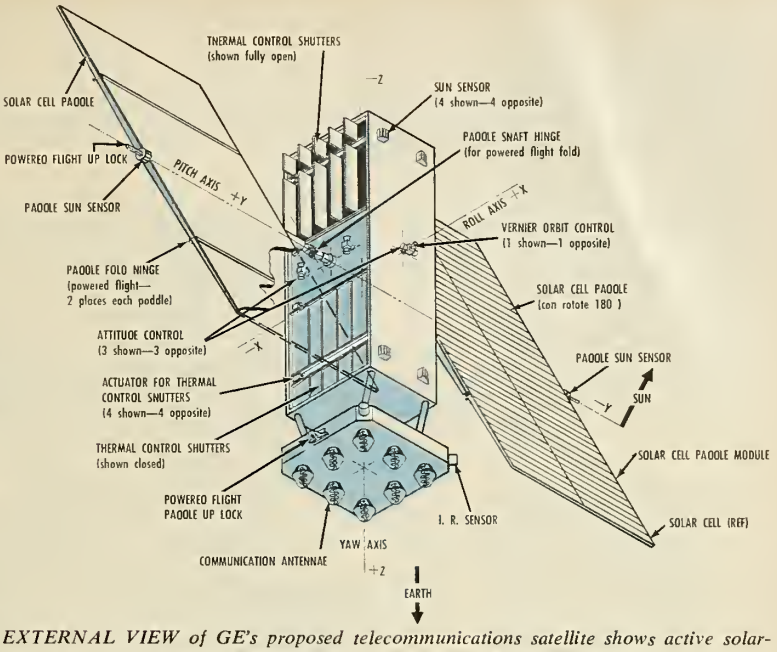
Although all transmitters would be designed to provide a 2-kw operational capability, the 300-message circuit units would operate at a 1.5-kw output level while handling traffic. Similarly, the 24-channel test transmitters would operate at a 1-kw level.

Telemetering equipment would be provided to establish remote monitoring of satellite condition and to provide command functions to space vehicles.

• **Space satellite design**—The communication equipment would be installed in satellites designed to travel in a circular orbit 6000 nautical miles above earth. The vehicles would be fully stabilized and earth-oriented. Active solar panels would constantly adjust themselves to face the sun, and the antenna axis would be pointed toward the center of the earth.

Solar cells would provide primary power to the communications equipment and to the satellite systems. Batteries would be used for power during the dark periods of an orbit and for power storage during the light ones.

The bus bar power requirements for each of the 300-channel communication units, including the outriggers, is 60 watts. Power requirements for the TV relay is estimated to be 150 watts, but used on an intermittent basis; intermittency is true even if TV service is continuous over portions of the globe. Hence, the total maximum power requirement for this equipment is 390 watts.



EXTERNAL VIEW of GE's proposed telecommunications satellite shows active solar-cell paddles, expelled-gas attitude-control nozzles, and IR and sun sensors.

Nevertheless, the power system would be designed to put out 700 watts. The added power would be needed for attitude stabilization and sensing equipment, the command and diagnostic telemetry equipment, the thermal control apparatus, some miscellaneous equipment and battery charging.

The satellite's total weight, including installed equipment, would be about the same as the Army's *Advent* satellite— 1000 lbs. More than 40% of this weight is charged to the electrical power generation and distribution system; this includes the weight of the solar paddles.

Twenty-five percent of the weight would go into communications electronics. And 16% would go into the attitude control system. The satellite's structure and the thermal control system would weigh only 80 lbs.

• **Guidance and control**—To get the desired orbit, ComSat proposes the following method for launching and guidance:

—First of two stages is radio-guided by Mistram until the vehicle reaches 11,500 fps.

—The inertially-guided second stage adds 20,000 fps to the vehicle's speed. At cutoff, the second-stage velocity is horizontal.

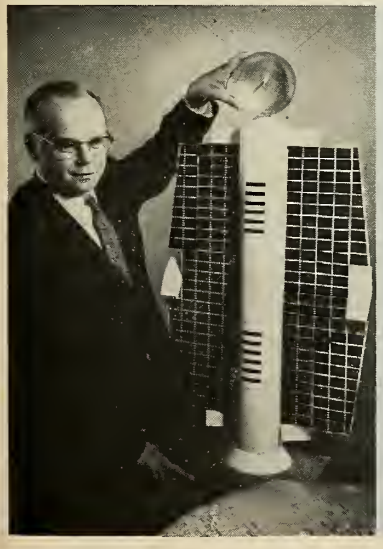
—A coast ellipse follows for a 1.8-hr. period to an apogee of 6000 nautical miles. During this time, the second stage is pitched over 180° and pointed forward for a second ignition.

—During second ignition, a velocity increment of 4200 fps is added; cutoff is effected by the inertial guidance system. The second stage is jettisoned, leaving the satellite in a roughly 6.33-hr. equatorial orbit.

The satellite's stabilization system, active and conventional, is based on a three-axis reference determined by the earth and the sun. IR horizon sensors and solar-cell sensors detect errors in attitude and correct them by inertial wheels. These can store small accumulations of momentum; larger accumulations are taken out by expelled gas.

ComSat is considering three boosters:

(Continued on page 27)



RCA Satellite Proposal

DURING the House Space Committee hearings on commercial communications satellites last week, a Radio Corporation of America executive called for a joint government-industry group to coordinate the efforts now under way. Dr. Elmer W. Engstrom, RCA senior executive vice president, also demonstrated a model of a synchronous satellite his firm is proposing for global communications. Traveling in a 24-hour circular equatorial orbit, the satellite would have its dish antenna aimed constantly earthward. Equipment in the vehicle would be powered by solar cells mounted on large fins flanking a cylindrical body.

Plant Tailors Refractories for Space

New DuPont center to make varied shapes of columbium alloy; other metals to come

THE FIRST plant designed specifically for the production of Space-Age refractory metal mill products has been put into operation by DuPont at Baltimore.

The new Metals Center will produce columbium and columbium alloy sheet, strip, plate, bars, tubes, and other shapes used by metal fabricators. The facility is designed so that tantalum, tungsten, and molybdenum products can be produced in the future.

The price for columbium mill products averages about $60 a pound.

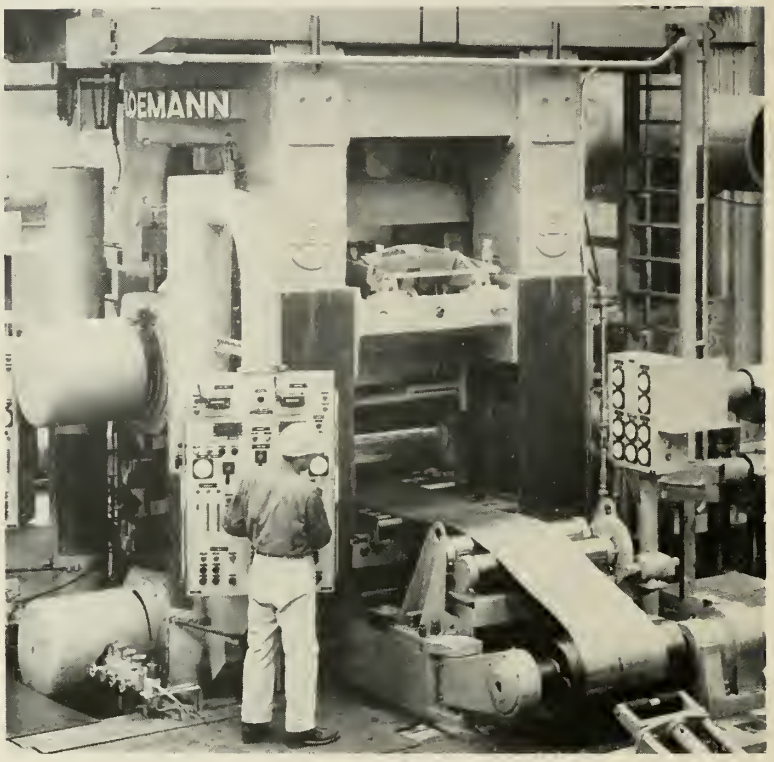
Refractory metals, used in high-temperature service, must be processed at extremely high temperatures. Columbium, for example, melts at 4500°F; iron is a liquid at 2800°F. To prevent contamination, refractory metals require special handling methods, and specially designed equipment, particularly in the heat-treating furnaces.

These new metals with outstanding physical properties are being developed to meet the needs created by advancing technology in the design of rockets, jet engines, nuclear reactors, and other Space-Age machines.

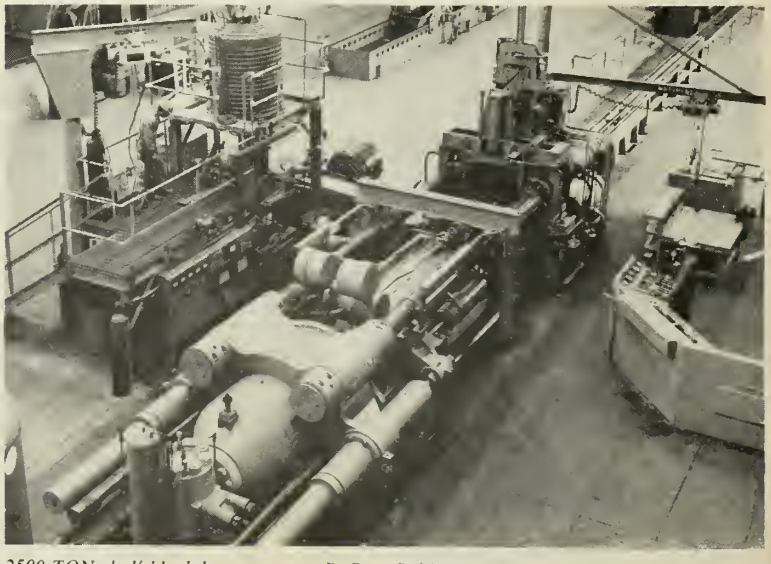
Until recently, columbium has been limited to use as an ingredient in stainless steel and in carbide dies and cutting tools. Researchers have found, however, that the refractory metal, when alloyed, possesses unusually high strength at high temperatures. DuPont has been experimenting since 1955 with production and fabrication of the metal and its alloys. A number of promising alloys have reportedly been developed by the company.

Columbium is an extremely ductile metal, easily fabricated and welded. In a pure state, it oxidizes (or burns) when heated, but its strength and oxidation resistance can be materially improved by alloying and coating. The metal also has a low thermal neutron-capture cross-section which makes it an excellent candidate for atomic energy applications.

In nuclear reactions, neutrons must be able to "filter through" structural material used in the reactors or the fission reaction is halted or impeded. Columbium alloys are among the most corrosion-resistant materials known. ⌘



ROLLING MILL can withstand a five-megapound separating force to cold-reduce a wide variety of refractory alloys with any one of four roll setups.



2500-TON, half-block-long press at DuPont-Baltimore utilizes unique heating, transfer mechanisms to quickly extrude refractories with minimum contamination.

Details of GE Proposal

(Continued from page 25)

the *Atlas-Centaur*, available in 1963, and the *Titan-Centaur*, available in 1964, each able to carry about 2900 lbs. of payload; and the *Atlas-Agena B*, available in 1962, able to carry about 940 lbs.

The National Aeronautics and Space Administration has already said that it would launch the satellites on a cost-reimbursible basis.

• **Temperature control**—The surface temperature of the satellite is expected to vary on each side of zero by 200°F. In addition, the heat put out by the internal electronic equipment can go up as high as 500 watts. Still, the design operating conditions require that the average internal skin temperature stay in the range between 50° and 75°F.

Both passive and active thermal control systems would be used. The passive system calls for areas of special coatings on the satellite, areas having low values of solar absorptivity-to-emissivity ratios. Where this method is not adequate, the active system would take over.

Temperature-actuated insulated shutters make up the active system. The vehicle's thermal balance can be maintained by appropriate opening of these shutters on the sides of the vehicle not facing the sun or the earth.

• **Ownership**—Asking that ComSat be owned by the aerospace and communications industry, GE recommends that no one company have more than a 10% interest.

A 10% interest would require a financial investment of about $25 million, since for the books the satellite portion of the system is being quoted at $250 million.

In addition, GE says that there should be at least a 5% ownership and risk position by each company in order to limit the number of participants to an administratively sound number. However, GE foresees that a block of stock may be set aside for public subscription.

On the other hand, AT&T is calling for a space relay system owned entirely by message-carrying organizations and appropriate international agencies. However, the company looks to the aerospace industry to produce the satellites, build the ground stations and supply the rockets.

All companies agree that establishing a commercial satellite communications system is an important national objective. They also agree that the system should be able to provide high-quality telephone service as well as all other existing forms of telecommunications—and that it should be built and put into service as soon as possible. ⌗

FOR
THE
MAN-IN-SPACE
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telemetry components

Dorsett Electronics is responsible for supplying much of the telemetering equipment for the Mercury spacecraft which will be used in the National Aeronautics and Space Administration's "Man-in-Space" program.

For this vital project, distinct and accurate telemetry signals on each channel are an absolute must. Only the highest quality workmanship and electrical performance is acceptable to engineering inspectors for McDonnell Aircraft, prime contractor.

Dorsett has designed, developed and manufactured the transistorized subcarrier oscillators, associated reference oscillator, and power supply mixer-amplifiers that will frequency-modulate and multiplex data in the Mercury manned satellites into transmittible and recordable form. These Dorsett-built components consistently meet McDonnell's standards.

The same high standards of quality and performance extend to the many other telemetering systems and components being supplied by Dorsett for today's advanced aerospace programs. For more information, write today!

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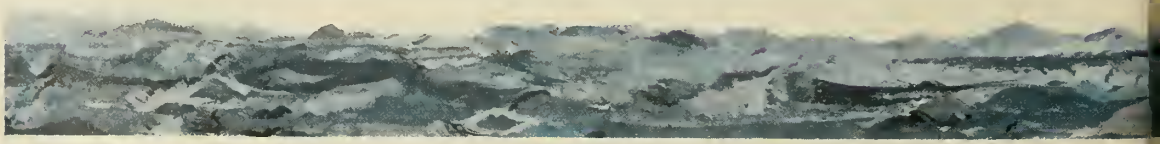


CLIMATE FOR CREATIVITY:

This is an artist's conception of the Air Force space craft Dyna Soar. Honeywell Aero has been selected both as an associate and as a sub-contractor for the critical guidance and flight control subsystems respectively on this delta-winged space craft that will carry one or more astronauts. The Dyna Soar will be sent into space by a Titan booster.

The Dyna Soar project is representative of the many advanced systems which are being evolved and developed into working hardware at Honeywell Aero. It is typical of the type of creative concept that poses a challenge to the engineer or scientist possessing imagination, drive, and talent.

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Select your area and send your résumé or request for information on specific openings to: Mr. Clyde W. Hansen, Technical Director, Aeronautical Division, 2638 Ridgway Road, Minneapolis 40, Minn.



Magnetogasdynamics Gains Reported by

Though much R&D remains to be done, laboratory leader sees much brighter prospect for use of MGD powerplant in space vehicle; next step is building a pilot engine

by Frank G. McGuire



NORAIR'S Sterge T. Demetriades observes operation of magnetogasdynamic engine in laboratory vacuum tank. The engine has delivered up to three lbs. thrust for durations as long as two and a half minutes.

HAWTHORNE, CALIF.—Three major advances in magnetogasdynamics have greatly brightened prospects for use of an MGD engine in space vehicles.

Resulting improvements in engine performance have enabled Norair Division of Northrop Corp. to obtain over three lbs. of thrust in a maximum operating duration of two and a half minutes with uncooled electrodes.

Sterge Demetriades, head of the Space Propulsion and Power Laboratory at Norair, said the three advances are:

—Achievement of a continuous and stable discharge with field emission which can pass high currents across the plasma stream.

—Discovery of a cool conducting sheath around the plasma jet with low momentum which reduces friction and erosion losses on engine electrodes to a negligible factor.

—Accelerating the plasma within a magnetic field higher than hitherto thought possible, plus a mode of operation which makes "ion slip" also a negligible factor.

Specific impulse currently being achieved is about 1400 seconds with argon, and efficiency is in the 40% range. Both values are expected to continue their rise with further effort.

Demetriades said a total of 140 kw is required for the three lbs. of thrust, 90 kw for the accelerator and 50 kw for the plasma generator. The available power supply is currently limiting some aspects of the program, and there are limitations imposed by the plasma generator, a commercial device.

• **Needs more R&D**—Regular testing schedules at Norair have been putting the engines through two- and three-lb.-thrust runs for durations of one and two minutes daily. These compare very favorably with the four-to-eight-ounce runs for short periods when the project got under way ten months ago.

Demetriades stressed that considerable work remains before an engine actually is in use aboard space vehicles, although the recent progress has brought this prospect much nearer.

The major components on which an MGD engine would be based are a powerful electrical energy source, probably a nuclear reactor; a plasma generator to create a plasma stream; and a plasma accelerator to provide thrust.

A systematic research study is strongly favored by Demetriades before hardware development is accelerated. The first step, he feels, is to continue research to optimize the engine and understand its fine points better.

Simultaneously, basic studies—such as research into the processes of energy transfer to plasmas by continuous Lorentz forces—should be continued, in order to provide an understanding of loss mechanisms, and thereby pave the way to reduce such losses.

"The next step," Demetriades said, "is to build a pilot engine to fit into a completely integrated space propulsion system capable of maintaining thrust for indefinite periods of time, perhaps years."

Equipment for this type engine is not available yet, he pointed out, and Norair hops to design and build special plasma generators, accelerators and special electrical generators to pioneer the effort required.

Present equipment is being used with uncooled electrodes, and this is a hindrance to run time. Cooled electrodes, through radiation and regenerative techniques, will greatly extend the run time. Norair is on the verge of installing a higher-power electrical supply system for the project.

Demetriades said an uncertainty of 15% exists in the propulsion efficiency measurements with argon as propellant, but the MGD efficiency obtained, excluding the plasma generator, is nevertheless greater than 30%. An even higher level of uncertainty—40%—exists with nitrogen or air as expellant, but the MGD engine efficiency is still over 10%.

He emphasized that no attempt had been made to optimize the geometry or efficiency of this particular engine. The existing uncertainties can be removed, however, by either mounting the plasma generator on the balance along with the MGD driver, or by direct and continuous measurement of the plamsa generator exhaust velocity or cooling losses.

Norair Div.

Both approaches to reducing the efficiency uncertainty are now being followed by the Norair laboratory.

• **Experimental equipment**—In laboratory work Demetriades and his associates, Dr. Richard W. Zeimer and C. F. Young, mounted an electromagnet on a balance located in a vacuum tank. The magnet had a capability of 12,000 gauss continuous or 15,000 gauss peak, and had a one-inch gap.

Pressure in the tank was maintained at about 2000 microns while the argon, nitrogen or air plasma jet from the arc source was exhausted into it. The plasma jet was directed between the pole pieces of the magnet.

The magnet-balance-electrode assembly was located about an inch from the end of the plasma jet nozzle, and the poles and electrodes about six inches from the same nozzle. Adjustable electrodes allowed the researchers to position them at the edges of the free jet of plasma, which had a diameter of about one inch. Balance reaction was then measured through strain gages.

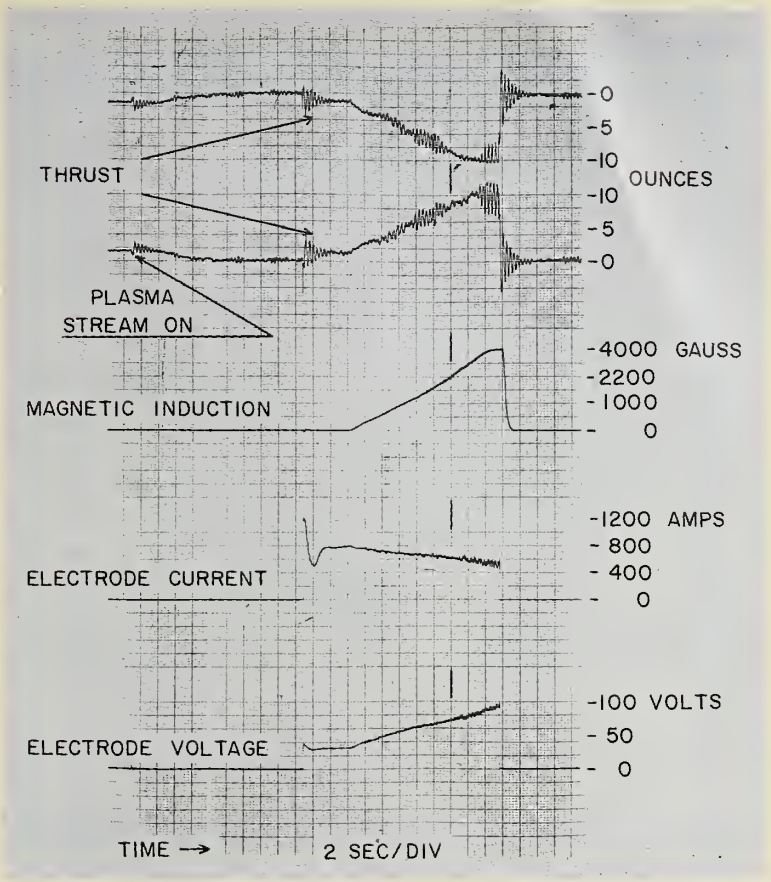
• **Experimental results**—Depending on polarity of the system, either a drag or thrust reaction was obtained from the balance when the electric current and magnetic induction were turned on while the plasma jet was streaming through the space confined by the pole pieces and the electrodes.

It was noted that the trailing edge of the anode was first to start glowing, and this region spread upstream and down the anode stem in a cylindrical front with the trailing edge for an axis. Indication is that the discharge probably stabilizes at the anode trailing edge.

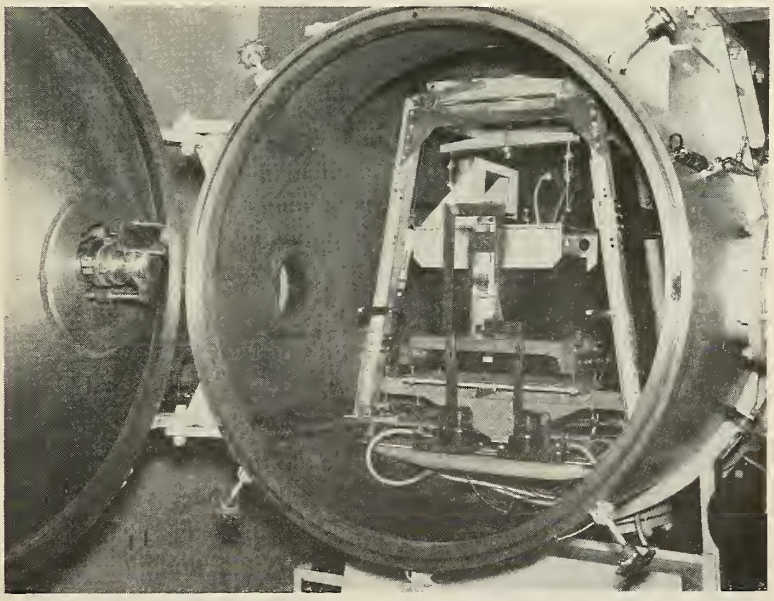
Another result was that the hot luminous core of the plasma jet could be a considerable distance (about ¼ in.) from the electrode surfaces without impairing the flow of current, implying that the core is surrounded by a conducting sheath due to the diffusion of electrons. The momentum of particles in the sheath appeared to be lower than the momentum of particles in the core.

Electrode current was varied from 10 amps per square inch to 2000 amps per square inch, while the electrode potential difference was varied from 24 volts to 360 volts. The flow rate of the argon expellant was about 1.40 gm/sec.

"The agreement between measured and computed thrust was excellent," Demetriades said. ⌘



TYPICAL EARLY TEST of Northrop's MGD engine (argon, electrode spacing 1.19 in., efficiency 25%). Subsequent test runs have boosted efficiency to 40%, and further efforts are expected to increase it still more.



VIEW OF the magnetogasdynamic driver on the thrust-measuring balance in Norair's vacuum tank. The plasma generator, mounted on the tank door at left, is a commercial device; the company hopes to build special generators.

Ancient Divider Still Hard at Work

Highly accurate machine built in 1896 still used by Warner and Swasey in scribing encoder discs, other specialized tasks

by Charles D. LaFond

A 19TH CENTURY circle dividing machine is finding its service just as much needed in this Space Age as it was some 65 years ago.

Designed originally by Ambrose Swasey, one of the founders of Warner and Swasey Company, Cleveland, Ohio, it still ranks as one of the most accurate dividing instruments in the United States.

Accurate to within one second of arc, the venerable machine was first used in the building of the 40-inch equatorial telescope for Yerkes Observatory in Wisconsin. That was in 1896.

Among its many recent assignments was the scribing of a master encoder disc for a modern numerically-controlled turret lathe.

• **Servo-Feed lathe**—W&S's electronically controlled turret lathe was first revealed last year. Designed from the floor up for automatic ultra-precision machining of missile and aircraft hardware, two of the first machines have just been installed at Thompson Ramo Wooldridge in Cleveland. Cost of each lathe was roughly $250,000.

Use of optical encoder discs for feedback signals on the W&S lathe is believed to be a "first" in the American machine-tool industry and possibly the first of its kind in world metalworking technology.

Designed with a 25-inch swing, the lathe features a built-in memory capable of assimilating up to 96 sequential commands. Each single command directs one function such as "change speed," "start rapid traverse," etc. Any command can be changed at any time without disturbing the remaining stored data.

Except for an incremental tape path-control system used only for contouring, no tape or outside programing is required by the machine.

All commands are inserted into storage by the set-up operator. He simply uses a push button at the end of an acceptable cut to insert all the necessary operating factors into machine memory.

To change a command, the operator permits the lathe to follow its normal work cycle up to the cut needing adjustment. The controls are then switched to manual while the new procedure is introduced. Again, the record button is engaged and the corrected command is inserted in memory in the proper sequence. Control is then returned to automatic operation.

Fine memory adjustments can be



LEFT: *Master encoder disc, 39 in. in diameter, is scribed into 2048 equal divisions. Later, after opaquing, it is reduced and reproduced photographically on thin optical glass measuring less than 3 in. in diameter.*



RIGHT: *First production models of the new W&S Servo-Feed turret lathe which use encoder discs for feedback control are currently being tested at Thompson Ramo Wooldridge, Cleveland, where the lathes will be used to machine automatically ultra-precision components for aircraft and missiles.*

n Space Age

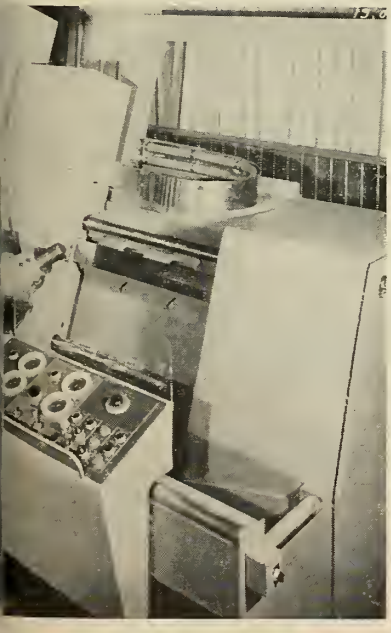
made to 0.0005 inch in a horizontal direction and to 0.00025 inch in a cross direction.

• **Optical encoders**—The superbly accurate master encoder disc produced on the old W&S divider machine measures approximately 39 inches in diameter. From this master, additional encoder discs are reduced and reproduced photographically to about 3 inches in diameter for mounting in the optical encoders of the Servo-Feed turret lathes.

In the lathe the discs function as light traps or gates, either passing or blocking rays from a light source to a series of photoelectric cells. The pattern of light reaching the cells through the discs is translated electrically into feedback signals for the turret lathe's memory and tape control sytem. The accuracy of the encoder discs is of paramount importance.

The master encoder disc was divided into 2048 separate equal divisions. At a diameter of 39 inches, this means each division is 0.059921 inch wide.

During scribing operations, the dividing instrument indexes this distance automatically, marking off divisions on the master disc—which was clamped to the circular table of the machine—at a rate of 3 lines per minute. The complete job took 11.4 hours, W&S said.



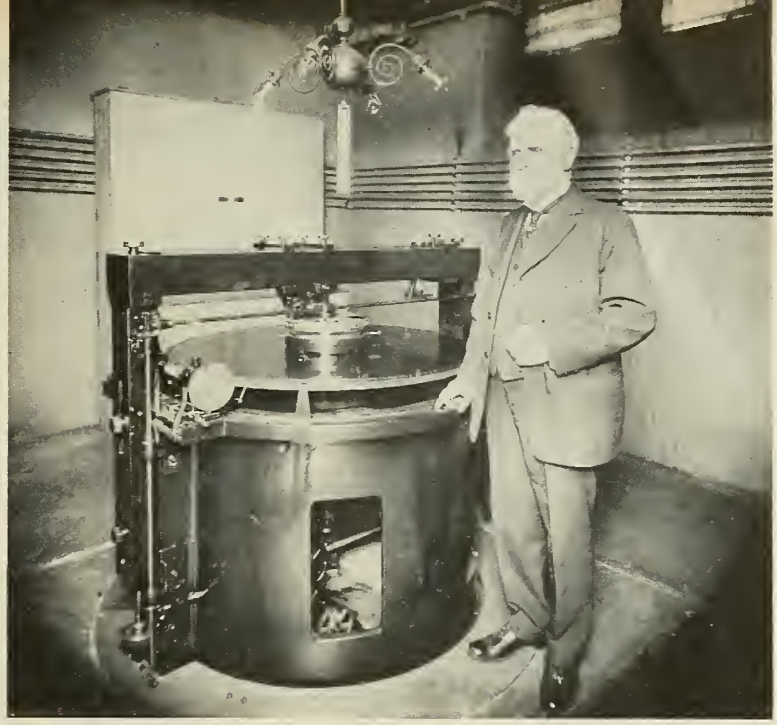
Scribing was done with a carbon steel cutter mounted on an overarm mechanism. Width of each scribed line is 0.0011 inch.

Once the master disc was divided, it then could be used for accurate plotting of the transparent and opaque areas of the encoder discs which go into the actual Servo-Feed lathe mechanisms. Working from the master, the plotted encoder disc image is reduced in size and reproduced photographically on thin optical glass to become the principal working element in the encoder.

• **Uses vary**—The old dividing engine appears still to have a long and useful future. In addition to its current work on encoder discs, the engine has been used in recent years for a number of special jobs for the U.S. and British Governments and industrial customers.

It was employed on components for the new 36-inch Schmidt telesope unit built by Warner & Swasey for the Case Institute of Technology observatory. Specially divided circles of low expansion silver were calibrated for the U.S. Naval Observatory for measurement of star tracks.

For Timken Roller Bearing Co. in Canton, Ohio, the divider was used recently to scribe circular components for a taper gage believed to be the most accurate of its type ever built. ⁂



65-YEAR-OLD Dividing Engine still is one of the most accurate circle dividing instruments ever built. Here Ambrose Swasey, designer of the machine and co-founder of Warner & Swasey Co., poses with his newly built instrument in 1896. It was first used that year, in construction of telescope for Yerkes Observatory.

Chemical Ignition Seen Feasible for Centaur

PROPULSION researchers have established the apparent feasibility of a chemical ignition system for hydrogen-oxygen rockets, a NASA technical report says.

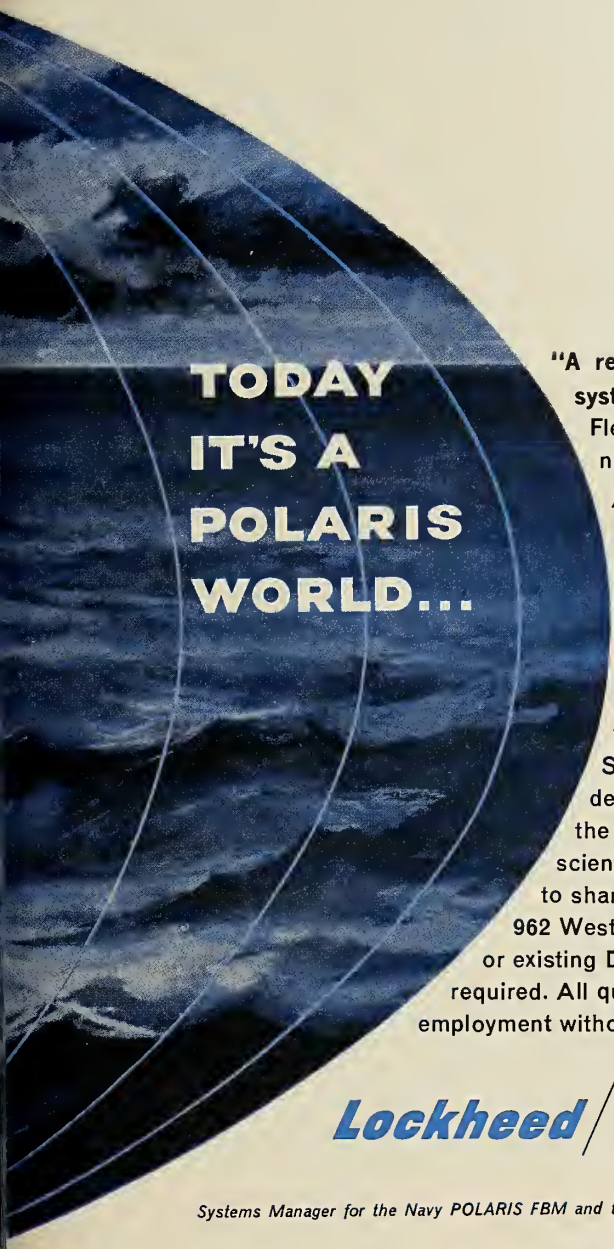
Chemical ignition might solve the problems that have caused six months of delay in the *Centaur* high-energy rocket. The *Centaur* program has been in trouble because of difficulty in simultaneously igniting its two engines with the present electric spark system.

John W. Gregory and David M. Straight of NASA's Lewis Research Center said in a technical note (D-684) that their results indicate it may be possible to create a small, compact chemical ignition system capable of being developed into a highly reliable component for hydrogen-oxygen engines.

Gregory and Straight studied the use of triethyl aluminum as a lead to the hydrogen fuel line, and chlorine trifluoride as a lead to the LOX line in a nominal 125-lb.-thrust combustor burning gases at 200°F.

Use of about 0.5 cu. in. (0.038 lb.) of CTF or about 1.0 cu. in. (0.031 lb.) of TEA were required for starts with ignition delay of less than 100 milliseconds. When the same amounts were added to a hydrogen-oxygen mixture containing 20% fuel, maximum ignition delay time was only 15 millisec. ⁂





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Similar challenging opportunities are continually developing at Lockheed. Other programs reach far into the future . . . a rewarding future which engineers and scientists of creative talent and inquiring mind are invited to share. Write Research and Development Staff, Dept. M-16A, 962 West El Camino Real, Sunnyvale, California. U.S. citizenship or existing Department of Defense industrial security clearance required. All qualified applicants will receive consideration for employment without regard to race, creed, color or national origin.

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Write for Bulletin CEC 4004-X2.

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A SUBSIDIARY OF **Bell & Howell** · *FINER PRODUCTS THROUGH IMAGINATION*

Hound Dog Data Sped by Relay System

DOWNEY, CALIF.—Collection time for *Hound Dog* test data has been reduced to a minimum by a unique system which relays the missile's actions over the Atlantic Missile Range to North American Aviation's Space and Information Systems here almost instantaneously—in about 18 milliseconds.

The system, used for development and checkout during captive flights of the missile, enables NAA engineers to monitor the flight while it is in progress and analyze critical data within a few minutes after the flight's conclusion. This trims days from the former method of compiling telemetry and radar information on magnetic tape, then flying the tape to Downey for evaluation.

First step in the transmission system is conversion of the *Hound Dog's* Verdan computer data to telemetry signals which are transmitted to a down-range receiving station. The telemetry data covers operation of the missile's guidance systems and subsystems rather than trajectory information. The receiving station further processes the telemetry data for transmission via submarine cables to the Radio Corporation of America telemetry station at Cape Canaveral. This transmission to the Cape includes the balance of tracking data necessary for full evaluation of the flight. The RCA station extracts the desired test information from the 60-odd bits transmitted from the missile, and relays it to the NAA division's test facility at the Cape.

The flight control center encodes the information for input to the microwave and telephone line link leased by NAA from American Telephone and Telegraph Co. which connects the Florida and California facilities of SISD.

Upon receipt of the information, the Downey computer facility demodulates the signals back to telemetry "language" and digitally translates the telemetry information for an IBM computer input. The final data is read out from the computer in decimal form onto IBM punch cards.

Radar tracking and trajectory data is relayed to the division's Downey headquarters through the same general network the morning following the flight. It is then combined with the guidance and performance information and processed to obtain a broad picture of the entire test. ⌗

← Circle No. 13 on Subscriber Service Card

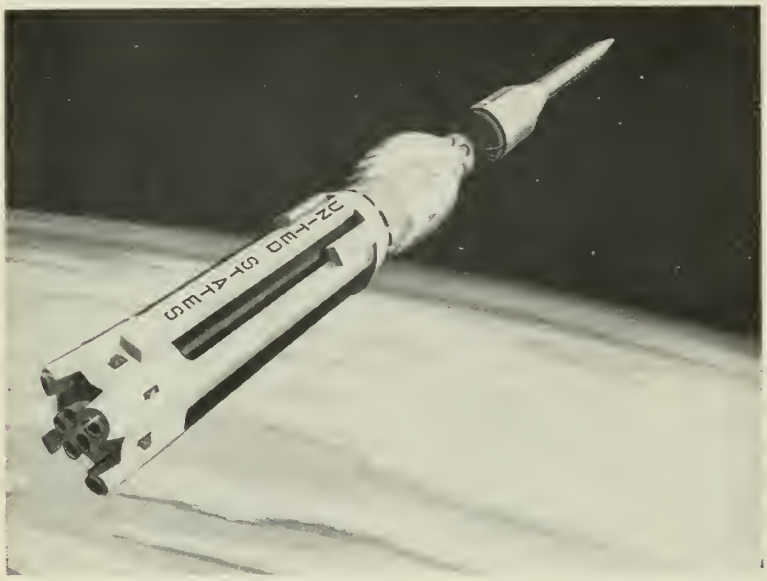


MAY 5, 1961—AMERICA'S FIRST MAN IN SPACE. *North American Aviation joins all of America in saluting Cmdr. Alan B. Shepard, Jr., USN—the Free World's first astronaut. The historic flight was a major step in America's man-in-space Mercury program, directed by the National Aeronautics and Space Administration. The power that put an American in space was provided by a Redstone liquid propellant rocket engine. The next step will be an orbital flight powered by an Atlas engine. Both the Redstone and Atlas engines are produced by the Rocketdyne Division of North American Aviation. Rocketdyne is now testing immensely more powerful engines. The Saturn booster will be able to orbit 40 tons. The giant F-1 engine, which has already achieved a thrust of 1,640,000 pounds, may well give America space supremacy. Rocketdyne is the Free World's leading producer of large liquid propellant rocket engines—engines that have already powered 36 out of 40 of America's successful satellites and space probes and that have proved their reliability for manned space flight.*

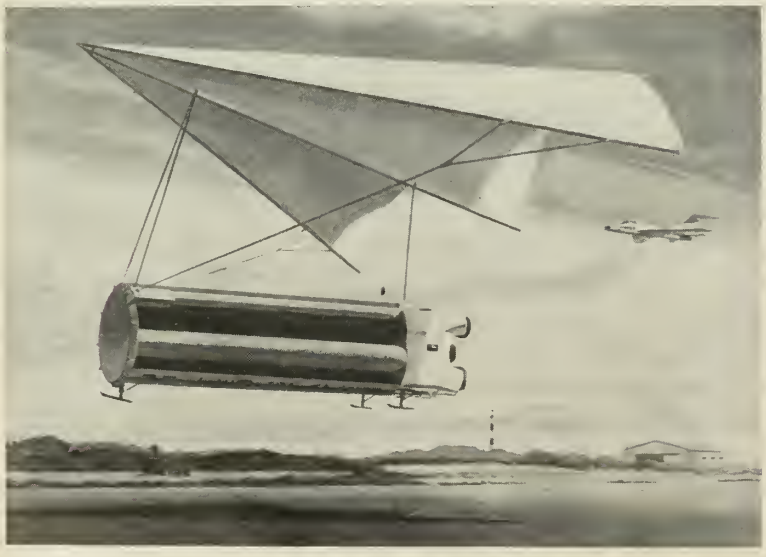
THE ROCKETDYNE DIVISION OF NORTH AMERICAN AVIATION

Saturn May 'Fly' Back to Launch Site

North American study envisions 'paraglider' in position to unfold on separation and carry booster home under radio control; many problems remain



BOOSTER SEPARATES from upper stages of Saturn in NAA artist's conception, and recovery system begins to unfold for trip back to launching site.



HOW PARAGLIDER AND BOOSTER might look on landing after radio-guided flight. Touchdown would necessarily be made at zero velocity to avoid damaging booster

DOWNEY, CALIF.—It may be possible to "fly" *Saturn* boosters back to near their launch sites at Cape Canaveral or to a down-range island for shipment back to the Cape, according to engineers at North American Aviation's Space and Information Systems Division.

An NAA study, one of two awarded to industry for development of a recovery system for the *Saturn C-2* booster series, calls for incorporating capabilities for a controlled touchdown at a fixed site. The booster recovery system would be guided by a modified radio control system of the type developed for the company's *X-10* research vehicle. Final flare pattern would be similar to that of the *X-10*, with touchdown at zero velocity in order to land the load—sensitive at zero g.

NAA favors the "paraglider" approach, proposed by the National Aeronautics and Space Administration's Francis M. Rogallo several years ago. In this configuration, the recovery system takes the general form of a triangle —similar to folded paper "darts" made by schoolboys for several generations. The idea appears quite feasible, NAA engineers say, but it is not easy to designate final hardware and configuration.

Basic structure for the paraglider consists of two leading edge booms and a keel. Between these structural members a covering of steel mesh, probably Rene 41, would be stretched. The mesh, in turn, would be coated with a silicone-based coating to form the aerodynamic supporting structure for the booster.

• **The hard part**—Up to this point, things are relatively simple. But then the problems really begin.

For one, where to put the recovery system on the booster? S&ISD engineers say that, for proper aerodynamic support of the *Saturn* booster, the booms will have to be about 100 ft. long. These booms, however, must fit within a 50-ft.-long space in the booster's tankage area. This means the booms will have to be articulated in some manner. Studies are being conducted of every approach—from a simple folding-boom assembly to a many-jointed, accordion-like boom arrangement. Some studies have also been made of using inflatable structures for the main members. The latter approach might solve some storage problems, but pose others.

The recovery system is also weight-restricted to 10,000 lbs., which has been

taken into account in the booster design as related to end payloads and missions. Because of this, titanium is being seriously considered for the boom and keel structures. These assemblies would most likely be made up of hollow tubes—either hinged for folding into the tankage space, or possibly telescoping.

Because the recovery paraglider should be maneuverable, some sort of auxiliary power unit will be required. Design and power of the unit will depend upon power requirements for the amount and rate of support cable reefing needed to properly guide the booster to the desired landing area. The reefing process poses still another problem in that the steel support cables will have to be one inch or more in diameter—a difficult size to "roll up." Project engineers are thinking in terms of about 300 hp.

Still another problem to be solved will be encountered even before the paraglider recovery system can be deployed.

When the booster separates from the upper stages, it becomes unstable. At its "ideal" empty weight of approximately 110,000 lbs., some type of stabilization system is necessary. S&ISD engineers believe a system of reaction jets on the booster may do the job.

Performance criteria for *Saturn* application of the paraglider system points toward a need for about 7000 sq. ft. of flat pattern area in order to meet a desired glide angle of about 15° and preflare landing speeds on the order of 70-80 knots. At supersonic and hypersonic speeds, paraglider wing loading is expected to be on the order of 15-18 lbs. per sq. ft.

Attachment points for the recovery system pose still another difficulty due to very sensitive g-limits on booster tanks. This also means that the paraglider may have to be fitted with some system to assure "easy" opening.

The recovery system is also expected to withstand calculated re-entry temperatures of over 1000°F. Booster velocities at burnout and separation are expected to vary between 2000 and 8000 ft. per sec. depending upon the mission.

• **Other uses**—The paraglider concept may also be used for an "air snatch" to increase the range over which the booster may be recovered. It might also be utilized as a supporting structure for boosters which could then be towed by an aircraft if the booster assembly can be equipped with a landing gear—either wheels or a skid arrangement. The tow concept would probably require an aircraft about the size of the C-133, to pull the paraglider and booster through the air.

The second study is being performed by Ryan Aeronautical Co. ⌘

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Temp. (°C)	Observed Density (g/ml)
60	0.5866
70	0.5780
75	0.5741
80	0.5688
90	0.5604
95	0.5561
100	0.5522
110	0.5431
115	0.5389

SOLUBILITY OF NITROGEN IN LIQUID B_5H_9

(Total Pressure 1000 ± 7 psig)

Temp. (°C)	Solubility		
	IGPP(1)	MR(2)	H(3)
30	68.7	0.0559	8.14×10^{-4}
50	68.4	0.0607	8.87
70	67.9	0.0644	9.48
100	65.9	0.0711	10.79
129	62.8	0.0722	11.50
150	59.6	0.0779	13.07

(1) IGPP, Ideal Gas Partial Pressure (atm. Abs)
(2) MR is moles gas/ mole pentaborane
(3) H is MR/IGPP

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Circle No. 12 on Subscriber Service Card

Titan II prototype . . .

Launch Proves Out New Silo Concept

OFFICIAL Air Force photo sequence of May 3 *Titan* silo launch at Vandenberg AFB, Calif., carefully avoids showing any details of silo configuration.

The unique flame-exhaust vent design of the prototype *Titan II* silo—first proved out in static-firing tests several weeks ago—apparently handled the actual launch with no heat or pressure damage to the missile. Not even the paint was scorched.

Cable visible in the photo at right was attached to the missile during the liftoff phase to get all possible data as it left the hole.

The launch tube—28 ft. in diameter and lined with 3-ft.-thick fibreglass acoustical damper—did not suffer any damage in the shot.









What MR-3 Means

(Continued from page 16)

volts on the isolated battery, before engine cutoff at 2 min. 20 sec. after liftoff.

Then he reported capsule separation, disarming of the automatic retrojettison and extension of the periscope. The retrorockets would have been jettisoned if it had been necessary to use the escape rockets. However, after engine cutoff, the escape tower was jettisoned and the retrojettison circuit was disarmed to avoid inadvertent loss of the retro package.

Next, the automatic system turned the capsule up to its orbit attitude with the blunt end 15° above the horizon.

Three minutes after liftoff, Shepard began control movements with the stick disconnected from the attitude control system. After turning it for pitch down, yaw left, pitch up, roll left, yaw right and roll right, he turned on the manual control handle.

Next, he went into manual pitch, yaw and roll movements. All worked well, although the manual system had been developing some trouble with valves sticking and heavy control forces in the checkouts before the flight.

• **"Beautiful view"**—Shepard and Astronaut Virgil I. Grissom, who specialized in monitoring the control systems, had worked out alternate procedures in case the manual controls should stick during the flight. The alternate procedures were not disclosed, but probably involved use of the "fly-by-wire" system in which the controls were moved by a circuit connected with a set of rheostats.

About 4 min. after liftoff, Shepard looked out the periscope to see what features he could identify. His first comment was "What a beautiful view."

He reported a cloud cover of 0.3 to 0.4 over Florida, which made it impossible for him to identify Cape Hatteras, 582 statute miles north of Cape Canaveral. However, he could identify Okeechobee, Fla., Andros Island and reefs off the coast.

Shepard's backup astronaut, John H. Glenn, had suggested that he look at this point to see whether he could identify any stars. If the flight had taken place on schedule at 7 a.m. (EST), the moon, Venus and Saturn would have made an interesting array in the southwest, close to the horizon. However, by the time of the actual flight—at 9:34 a.m.—the moon had set. He could not identify any stars.

Four and a half minutes after liftoff, Shepard positioned the spacecraft for retro firing and fired the three retrorockets at a little past 5 min. Each motor burned 10 sec. They were fired at overlapping 5 sec. intervals. The retros will reduce 500 fps from the 25,200 fps orbital velocity.

• **Light fails**—Next, the retrojettison was rearmed and he switched the control system to fly-by-wire at about 6 min. after liftoff. About 30 sec. later, the retro package was jettisoned on schedule—after which occurred the only reported capsule malfunction.

A light that was to have confirmed retrojettison failed to come on. However, Shepard saw the straps falling away and heard the noise when the explosive bolts were actuated. Thus he knew the jettison had taken pace. Nevertheless, he used a manual override to confirm and received the green light verifying his knowledge.

The malfunction delayed by a few seconds Shepard's turn into re-entry attitude, which was to have begun before the periscope automatically retracted at about 6:45. However, he made the movement before a trace of re-entry deceleration appeared—a few seconds after 7 min. At that point, he switched the control system to automatic and checked out the high-frequency backup radio channel. It performed well and he returned to UHF.

• **Re-entry begins**—Coming up on 8 min., the g loads began to increase. He reported 3, 6, 9 and then said "OK" three times—his voice little more than a grunt as he strained his stomach muscles against the load. The whole buildup to more than 11 g's and then the dropoff took about 30 sec.

At this point, the computers reported the capsule impact prediction would be "right on the button" and the Carrier Lake Champlain waiting downrange took on full steam to reach a point calculated at seven miles away.

Actually, the capsule traveled 12 miles farther than the nominal 290 miles. In its only malfunction, the *Redstone* burned a second or two too long.

Descending at a speed of about 300 mph, Shepard reported altitude of 30,000 ft. At that point, some communication difficulties developed as expected, as the capsule fell low toward the horizon from Cape Canaveral. The tape later disclosed that he reported 25,000 ft. about 8½ min. after liftoff, but those in the control center at the Cape were not certain at that moment.

Communications at that point were switched to a link with Grand Bahama Island, only 80 miles away from the impact area, and Shepard reported deployment of the drogue chute at 21,000 ft., just as planned.

Further difficulty in communication caused concern in the control center about deployment of the main chute, which was to have been at 10,000 ft. Shepard reported his altitude at 7,000 ft. a little later but neglected to mention the main chute.

Astronaut Donald K. Slayton, on capsule communications (CapCom) asked for "Card File 23"—confirmation of main chute—but only part of Shepard's words came through. The first to know the chute had deployed were sailors on the Lake Champlain.

Shepard finally got through with the statement "everything A-OK" and reported his dye marker was out. Helicopters from the Champlain reached the capsule and circled around it for the last few hundred feet of descent.

The flight lasted 15 minutes—from 9:34 to 9:49 a.m. (EST). He climbed out of the capsule, took a hoist into the copter and was on the deck of the Champlain 26 min. after liftoff.

Shepard said the only discomfort he suffered was in the final 11 min., after he had disconnected the air-conditioning system from the pressure suit. The heat bothered him.

• **Long wait**—The astronaut had been in the capsule for four hours and 14 min. before the liftoff. The hatch had been closed for three hours and 24 min. Nevertheless, Dr. Stanley White, Project *Mercury* flight surgeon, said he had been prepared to leave Shepard inside for another two hours or more.

A number of brief holds delayed the scheduled liftoff 29 minutes. Then, at 7:14, launch director Kurt Debus called a 15-20 min. hold for a look at the weather. A bank of clouds, which had blown in over the launch area, would have interfered with optical tracking.

The clouds began to blow away and Debus and *Mercury* Operations Director Walter C. Williams decided to resume the count at about 7:45. At this time, however, a DC-AC inverter in the *Redstone* developed frequency drift and had to be replaced. The count was recycled to T-35 with an estimated delay of an hour. The count was actually resumed in 52 min.—at 8:40.

The count moved back to T-15 by 9 a.m., when a computer at Goddard Space Flight Center—1000 miles away in Greenbelt, Md., began giving trouble. It required 18 min. to straighten out and the count was resumed at 9:18.

The preparation continued until 9:30, when the hydrogen peroxide pressure in the capsule control system suddenly overshot by about 100 psi. The pressure was relieved by operating valves by remote control from inside the blockhouse, and the count was resumed after a minute and a half.

In a press conference later, Col. Robert S. Maloney, deputy commander of the Atlantic Missile Range, noted the problems before liftoff and said:

"At that time, Cmdr. Shepard took over and everything seemed to work perfectly. All I can conclude is that man is a lot better than a machine. And the sooner we get men into space, the better we will be." ⌘

'Lift Off and the Clock Is Started'

Following is a transcript of the messages between Cmdr. Shepard and ground control during his 15-min. flight. Times of the messages and some of the ground control (VOICE) comments have been deleted by NASA.

Voice: One minute and counting, mark. Forty-five and counting, mark.
Shepard: Roger.
Voice: Firing command, 30, mark.
Shepard: Roger. Periscope has retracted.
Voice: That is the best periscope we've got.
Shepard: Main bus 24 volts, 26 amps.
Voice: 15, 10, 9, 8, 7, 6, 5, 4, 3, 2, 1, zero. Lift off.
Shepard: Roger, lift off and the clock is started.
Voice: . . . . . .
Shepard: Roger, reading you loud and clear.
Voice: . . . . . .
Shepard: This is Freedom VII, the fuel is go. 1.2 G, cabin at 14 psi, oxygen is go.
Voice: . . . . . .
Shepard: Freedom VII, it is still go.
Voice: . . . . . .
Shepard: This is VII, fuel is go, 1.8 G, 8 psi cabin, and the oxygen is go.
Voice: . . . . . .
Shepard: Cabin pressure is holding at 5.5.
Voice: I can understand; cabin holding at 5.5.
Shepard: Fuel is go, 2.5 G. Cabin 5.5. Oxygen is go. The main bus is 24, and the isolated battery is 29.
Voice: . . . . . .
Shepard: O. K. It is a lot smoother now. A lot smoother.
Voice: Roger.
Shepard: . . . fuel is go, 4 g, 5.5 cabin. Oxygen. All systems are go.
Voice: All systems go. Trajectory O. K.
Shephard: 5 G. CAP SEP (capsule separation). Green.
Voice: Roger.
Shepard: Auto retrojettison circuit disarm. CAP SEP is green.
Voice: Periscope is coming out.
Shepard: Periscope is coming out; and the turn around has started.
Voice: Roger.
Shepard: ASCS. Control movements.
Voice: Roger.
Shepard: O. K. Switching to manual pitch.
Voice: Manual pitch.
Shepard: Pitch is O. K. Switching to manual yaw.
Voice: I understand. Manual yaw.
Shepard: Yaw is O. K. Switching to manual roll.
Voice: Manual roll.
Shepard: Roll is O. K.
Voice: Manual roll.
Shepard: Roll is O. K.
Voice: Roll O. K. Looks good here.
Shepard: On periscope. What a beautiful view!
Voice: I'll bet it is.
Shepard: Cloud cover over Florida, three to four tenths in the upper east coast, obscured up through Hatteras. Can see Okeechobee, identified Andros Island, identified the reefs.
Voice: Roger. Count down on retro: 5, 4, 3, 2, 1, retroangle.
Shepard: Start retro sequence and retro attitude. Green.
Voice: Roger.
Shepard: Control is smooth.
Voice: Roger, understand, all going smooth.
Shepard: Retro 1 fired, very smooth.
Voice: Roger, Roger.
Shepard: Retro 2, Retro 3, All three retros are fired.
Voice: All fired on the button.
Shepard: O. K., three retros fired. Retrojettison on.
Voice: Roger. Do you see the booster?
Shepard: Negative.
Voice: Roger. Switching fly by wire. Fly by wire. Understand.
Shepard: All is O. K.
Voice: Roger. . . .
Shepard: Roger. I do not have a light.
Voice: Understand you do not have a light.
Shepard: I do not have a light. I see the straps falling away. I heard a noise. I will use override.
Voice: Roger.
Shepard: Override used. The light is green.
Voice: . . . retrojet?
Shepard: Roger. Periscope is retracting.
Voice: Periscope retracting.
Shepard: . . . going into re-entry attitude.
Voice: Re-entry attitude. Roger. Trajectory is right on the button.
Shepard: O. K., Buster. Re-entry attitude. Switching to ASCS normal.
Voice: Roger.
Shepard: ASCS is O. K.
Voice: Understand.
Shepard: Switching to HF for radio check.
Voice: . . . on HF. Back to UHF.
Shepard: All clear. This is Freedom VII.
Voice: . . . . . .
Shepard: 3, 6, 9. O. K. O. K. O. K. (calling off G- stresses)
Voice: Coming through loud and clear.
Shepard: O. K. O. K.
Voice: . . . CapCom (Capsule Communicator), your impact will be right on the button.
Shepard: 30,00 feet.
Voice: CapCom, I can read you now.
Shepard: Roger, Deke. Loud and clear. How me? 25,000.
Voice: Switching over to G. B. I.
Shepard: Roger. The drogue green at 21,000, the periscope is out. Good drogue. The drogue is good. Seventy percent auto, nine-zero percent manual. Oxygen is still O. K.
Voice: CapCom, can you read?
Shepard: Thirty-five feet per second.
Voice: CapCom, can you read?
Shepard: I read.
Voice: CapCom, how do you read now?
Shepard: . . . CapCom, glad to be here aboard. I am at 7,000 feet. My condition is good. Landing bag green. Descent good.
Voice: Roger.
Shepard: . . . Altitude 4,000 feet. Condition as before. . . . Feels good. Will land.
Voice: CapCom, this is Card File 23.
Shepard: This is . . . Cap Com.
Voice: This is two-three, over.
Shepard: . . . Will you please relay. Need information.
Voice: Freedom VII reports good drogue . . . deployed 7,000 feet. . . .
Shepard: All O. K.
Voice: Card File 23 from Freedom VII. 4,000 feet condition as before. Main chute good. Landing bag deployed. Peroxide dump.
Shepard: CapCom, everything AOK. Dye marker out. Over.
Voice: Coming alongside now.
Shepard: CapCom is alongside . . . now. Over.
Voice: Astronaut now on board.

Redstone—At Last

(Continued from page 17)

have launched the first American satellite in 1951.

It was no use. His proposal to launch a man into space at the first possible moment was rejected.

Redstones were to be deployed with U.S. troops. But, as far as the space race went, *Redstone* again was sent to pasture.

• **Last fling**—Three years passed. Then, on April 12, 1961, Soviet Cosmonaut Yuri Gagarin made his historic trip around the earth in the world's first manned satellite. The first attempt to launch an American in a far smaller satellite was still anywhere from eight months to a year away.

Once again the *Redstone* entered the space race.

By this time *Redstone* was a pretty old horse. It had been given some new modifications for the occasion. But, it was still the now-obsolescent missile that the Army called "Old Reliable."

The *Redstone*—the 62nd ever to be launched—was placed on Launching Pad No. 5 on May 5; a *Mercury* capsule was stuck on top of it; and Cmdr. Alan Shepard climbed aboard for his ride 115 miles up and 302 miles downrange.

Headlines throughout the world proclaimed the event. The following Monday Shepard rode in triumph down Pennsylvania Avenue. President Kennedy gave him a medal and a day-long celebration was held.

It was almost as if the calendar said 1959 . . . or earlier.

"Old Reliable" had done what Von Braun had said it could do all along. It was just a little late. ⁂

America's first Astronaut staked his life on the proven reliability of a solid propellant escape rocket in his flight to the threshold of space. Dubbed the "Little Hero" rocket because of its reliable performance, the GCR Escape Rocket would have been triggered into action by a booster malfunction, and would have carried Commander Alan B. Shepard, Jr. and his space capsule to safety. The 0.999 operational reliability of GCR's Escape Rocket has been demonstrated in more than 60 firings without a failure.

GRAND CENTRAL ROCKET CO.
Redlands, California



Special Report

Experts Warn of Life Support Gap

by Heather M. David

LEADING space experts this week offered both optimism and pessimism for the future of the U.S. space effort.

Dr. Theodore von Karman, the noted aerospace scientist, said the United States could close the gap in the East-West space race within five to eight years "with real work." He said it was a matter of "taking the thing seriously."

Von Karman particularly stressed the possibility of developing an aerospace plane and called the *Dyna-Soar* "very important as the best preparation for the orbital aircraft."

• **The new gap**—In Washington and other parts of the country, several top space medicine experts warned that the United States not only suffers from a booster gap but from a gap in the development of space life support systems as well.

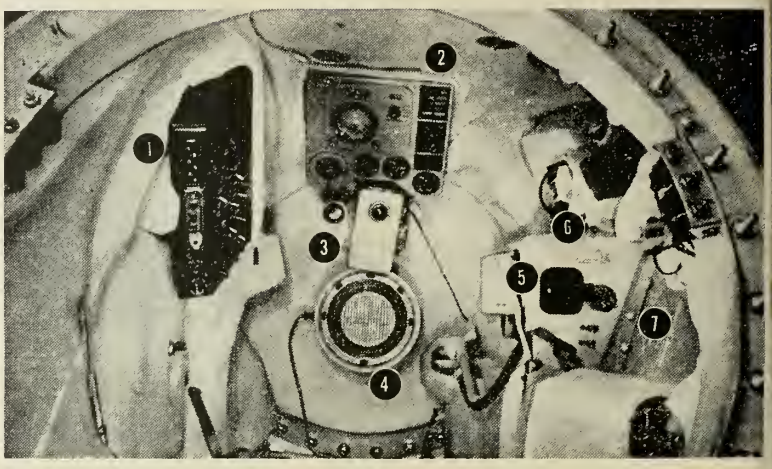
The space medicine experts base their statements on information gathered so far on the April 12 flight around the earth by Cosmonaut Yuri Gagarin in a more-than-five-ton spacecraft.

They said that if the United States had a spacecraft similar in size to Gagarin's *Vostok*, the life support and safety equipment could not be duplicated at this time. They said they might be able to develop such equipment in three years.

The most significant fact about the Soviet accomplishment is that although *Vostok* made only one orbit, the cosmonaut had oxygen, water and food for at least ten days. This seeming super-redundancy guaranteed his life if his retrorocket or braking system failed, since the Soviets figured that orbital decay would bring him down within that time. As a matter of fact, the last-stage rocket came down in six days.

The life support system for the orbital *Mercury* shot—all stored supplies—will last 48 hours.

The system is described by *Pravda* as a completely regenerative system which removed carbon dioxide and liberated oxygen. Although a number of companies are working on similar systems in the U.S., none is within a year of being flight-ready—and we aren't completely sure what weightlessness will mean in terms of engineering.



Vostok: Interior View

GAGARIN'S CABIN held 1) pilot's control panel, 2) instrument panel with globe, 3) television camera, 4) porthole with optical orientation instruments, 5) steering handle, 6) radio receiver, and 7) food container.

• **Sea-level atmosphere**—*Pravda* claimed that *Vostok*—and the *Sputniks*—had a sea-level atmosphere with a "normal" concentration of oxygen.

The maintenance of the two-gas system necessary to attain anything near sea-level pressure shows a technology of which the U.S. is not presently capable. And we must assume considerable sophistication in the sensing equipment which they described as "adjusting itself automatically if excessive oxygen is liberated."

U.S. plans for existing projects call for atmospheres of ⅓ to under ½ sea-level pressure with 100% oxygen. This provides the adequate partial pressure to support human respiration. However, we can't be sure a man can operate at maximum effectiveness in this unnatural atmosphere over a period of time. All experts agree that the way to get best performance is to give the astronaut conditions matching as closely as possible those to which he is accustomed.

• **Air-conditioning**—The Soviets described the cabin air-conditioning as an extremely accurate system utilizing a liquid cooling agent. The cooling agent flows from the thermoregulating system into a liquid pneumatic radiator. Air flow through the radiator is controlled automatically. The Russians also said they used a solar heat exchanger situated at the outside surface of the apparatus compartment to maintain stable temperature in the cooling agent.

• **Medical monitoring**—With the experience and testing accumulated in three years of biomedical flights, the Soviets have reached a level of technology in bioinstrumentation which also far surpasses any U.S. effort, many experts are saying. Gagarin's pulse, respiration, electrocardiogram (EKG), muscle tonus, electroencephalogram (EEG), and the force of his heartbeat (by a ballistocardiograph) were telemetered to the ground.

The U.S. does not have a flight-worthy electroencephalograph, ballistocardiograph or blood-pressure sensor. These measurements may be very significant in terms of learning of mental deviation and of how vigorously the heart and circulatory system is performing in longer periods of weightlessness. This has a bearing on his readaptability to a normal g environment and his ability to withstand re-entry.

Two slow-scan television cameras monitored Gagarin's facial expressions from side and front, certainly an advantageous feature. Weight requirements preclude use of TV in U.S. vehicles. ⌘



Life support system for the American astronaut . . .

this vital contribution to the success of the National Aeronautics and Space Administration's first Project Mercury sub-orbital manned space flight represents a new concept in environmental systems simulating the pressure, temperature and other physiological conditions found on earth. This important achievement is but one more example of Garrett's proven capability in the design and production of major systems and components for high altitude flight and space exploration.

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Transistorized Sensitive Relay

A transistorized sensitive relay with high impedance input for stop motion, inspection, sorting, and positioning of machinery is available from General Electric's General Purpose Control Department. The relay can be used in conjunction with photocells, thermistors and liquid level probes.

The advantage of the transistorized relay is that it needs no time for warm-up as with vacuum tube relay amplifiers. The transistorized relay is rated at 10 amps, 300 volts, a-c; it has double pole, double throw contacts.

Circle No. 225 on Subscriber Service Card

Gain-Loss Instrument

The Gain Set Model 625-A, an instrument for measuring gain, loss, noise figures and other transmission characteristics of both systems and components in the UHF, VHF and microwave frequencies is being marketed by Kay Electric Co.

Completely self-contained, the Gain Set incorporates mixing, I-F amplifying, attenuating, detecting and indicating elements, as well as the associated power supply and control circiuts required in an integrated measuring system. Aside from providing all of these features, the Gain Set has low noise figure and is highly stable.

Circle No. 226 on Subscriber Service Card

Electrodynamic Shaker

Ling Electronics Division of Ling-Temco Electronics, Inc., is marketing electrodynamic shaker, Model 300, with 5,000 lb. force rating and built-in "piggy-back" capability for environmental testing.

The basic shaker needs no accessories for piggy-back application and features Ling's closed-loop cooling system for field and armature structures.

Armature weighs only 49.5 lbs., with coolant, providing for larger payloads.



Maximum load for 10 g vector is 450 pounds, for 20 g vector 200 pounds. Maximum acceleration is 100 g's. Frequency range is 5 to 3,000 cps. Low voltage requirements of armature make Model 300 ideal for evacuated chamber applications.

Circle No. 227 on Subscriber Service Card

Pitot-Static Tube

Highly accurate static pressure for both subsonic and supersonic flight is provided from a single pair of static pressure ports in a pitot-static tube developed by Rosemount Engineering Co.

The aerodynamically compensated pitot-static tube eliminates the necessity for separate subsonic and supersonic pressure inputs to instruments. It also avoids the need for the large computed correction which was required with all previously available pitot-static tubes.

Circle No. 228 on Subscriber Service Card

All Purpose Choke Series

A general purpose line of coil wound chokes, Series 2952, for both civilian and military applications, is available from Cambridge Thermionic Corp.

The six chokes in this series range in fixed inductances from 1 millihenry to 1000 millihenries. They have excellent self resonant frequency and current carrying capacity. Commercial applications embrace industrial uses such as instruments and control equipment. They are also employed in a wide variety of military applications where high quality is desired, but environmental stresses are of a moderate nature.

Circle No. 229 on Subscriber Service Card

Tape Reader

Data Stor Division, Cook Electric Co., is marketing its Model 90 Photoelectric Tape Reader which provides a total punched tape capacity of approximately 500,000 bits of information.

This photoelectric tape reader is suitable for "on-line" service in computer, communication and control applications. Data, in the form of coded hole sets, are photoelectrically read from pre-punched tape and transformed to electrical output pulses.

Circle No. 230 on Subscriber Service Card

CT Water Circulator

A constant temperature recirculating unit for close temperature control of distilled water has been developed by Mayer Refrigerating Engineers.

Model J-2S is designed to store up to 10 gallons of distilled water and to

deliver it at controlled flow rates to 10 gpm at 80°F ±3°.

Rated capacity of the unit is 750 btu per hour at 80°F. It combines both heating and cooling elements and has an operating range from 0°F to 95°F. Temperature can be controlled within ±0.75°F.

Circle No. 231 on Subscriber Service Card

Low-Input Amplifier

Rustrak Instrument Co. is marketing a 114 Amplifier designed to operate with Rustrak recorders. It is suited for the output of low-voltage thermocouples; photoelectric devices; and other transducers with outputs in the low millivolts.

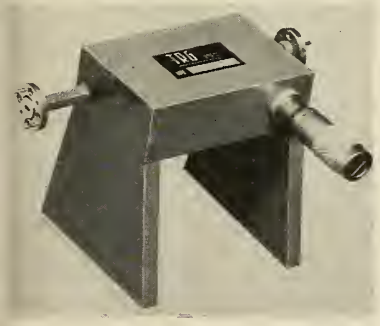
The input impedance is 100,000 and the gain is continuously variable so that inputs from 9 to over 45 millivolts will produce full-scale deflection on a standard Rustrak 1 MA recorder. Because of the high impedance input, cold junctions of thermocouples can be almost disregarded. The thermocouple can therefore be located at considerable distance from the amplifier and recorder without degradation.

Circle No. 232 on Subscriber Service Card

Tunable Ferrite Isolator

Technical Research Group, Inc. is marketing a tunable ferrite isolator for A, V, and E bands. An F band is under development.

The FERIMAT operates over the full waveguide frequency range, doing



the work of half dozen or more fixed tuned isolators. Typical performance ratings for A, V, and E bands are VSWR 1.25 max.; isolation 20 db minimum; loss, 1.5 db max.

Circle No. 233 on Subscriber Service Card

Flame-Retardant Epoxy

A flame-retardant epoxy resin for hot-melt castings and dry lay-up laminating systems is available from Union Carbide Plastics Co.

Combined with aromatic amine or anhydride hardeners, the epoxy, designated Bakelite ERL-0625, forms cured systems with physical, electrical, and

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Senior & Intermediate Level Positions In These Areas:

STRUCTURAL ANALYSIS: thermal protection systems for re-entry vehicles.

STRUCTURAL THEORY: advanced problems in thermal & mechanical stresses of plate & shell structures, elastic and inelastic regimes.

STRUCTURAL CONFIGURATION RESEARCH: design problems of very large and/or lightly loaded structures; also heavily loaded vehicles.

STRUCTURAL DYNAMICS: preliminary design calculations of loads, stresses, deflections of structural components (aircraft, missiles, boosters, space vehicles).

THEORETICAL AERODYNAMICS & AEROPHYSICS: original work supporting design and laboratory project experiments re: hypersonic re-entry vehicles; supersonic craft.

AERODYNAMIC PROJECT DIRECTION: studies & appraisals of preliminary aerodynamic designs for diverse flight regimes, including drag analysis, configuration optimization, performance & trajectory analysis.

AERODYNAMIC ANALYSIS & SYNTHESIS: for both powered & ballistic trajectories.

MATERIALS DEVELOPMENT: refractory coatings on refractory metals, & refractory compounds, cermets, intermetallic compounds. Initiation of investigations to meet new requirements.

EXPERIMENTAL CRYOGENICS: establishment & supervision of cryogenics laboratory responsible for varied investigations including developing environmental control systems for spacecraft.

GUIDANCE & CONTROL SYSTEMS: novel components & system development; thin film devices; circuitry; optical & IR systems & tracking devices.

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chemical resistance properties similar to those of conventional diglycidyl ether of bisphenol-A epoxies. Anhydride hardeners give the best high-temperature stability. The resin readily passes the ASTM D-635, 30-second ignition flammability test.

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new literature

SEMICONDUCTOR GUIDE—A Semiconductor Selector Guide which includes technical data on 43 devices for military applications is available from Sylvania Electric Products Inc. The 16-page brochure lists the mechanical construction and electrical ratings of "every transistor, diode, rectifier, and microwave diode in the company's 500-type semiconductor line." The military units consist of germanium alloy and mesa transistors, microwave diodes, and point contact, gold-bonded, silicon-bonded and silicon junction diodes which meet the specifications of MIL-E-1, MIL-S-19500, MIL-T-19500, and other USAF, USN and JAN ratings.

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CARBON AND GRAPHITE—Carbon and Graphite for High Temperature Applications, a technical bulletin, has been published by Speer Carbon Co. It describes the unusual properties and the more important and interesting qualities of the various grades of carbon and graphite. It reviews their application in machining molds, dies, crucibles, sintering boats and other items that require resistance at high temperatures.

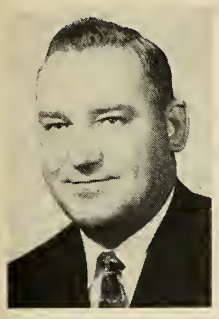
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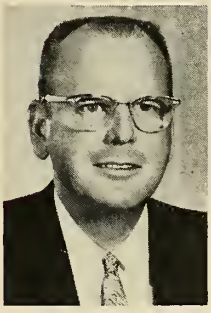
ELECTRO-MECHANICAL — The Sterling Instrument Division of Designatronics, Inc. has published a catalog describing its complete line of over 20,000 stock items. It is divided into sixty-seven product categories including speed reducers, magnetic clutches and brakes, differentials, electronic hardware, teflon terminals and limit stops. Within each category, part numbers, OEM list prices, specifications, and test reports useful in design and prototype work are presented.

Circle No. 202 on Subscriber Service Card

MODULES—A 12-page catalog on Computer Control Company's one-megacycle, T-PAC plug-in digital modules has been published. The catalog includes all of the latest specifications and the most recently announced T-PACs and auxiliary equipment. The new WL-10 Word Memories, TP-12 BLOC Power Supplies, RP-10 Rack Power Supplies and other recent additions to the T-PAC family are described.

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SHELDON


FLANAGAN


WELKOWITZ


ROSS


BERINATI

R. L. Johnson: Chief engineer for Douglas Aircraft Co., announces establishment of separate technical organizations—one for space and one for missiles—within the missiles and space systems engineering department. **M. W. Hunter** appointed deputy chief engineer-space, and **G. V. Butler** assistant chief engineer-space. **C. S. Perry** appointed deputy chief engineer-missiles, and **A. J. Carah** assistant chief engineer-missiles.

Dr. Walter Chestnut: Named director of newly-formed Space Physics Division of G. C. Dewey and Co., Inc., New York City. The Division will continue work in nuclear energy and fusion research and will specialize in space physics, plasma physics and space environment research. **Walter E. Landauer** joins Dewey Corp. as senior associate in charge of its electronics laboratory. Prior to joining Dewey, Landauer was head of a group engaged in ground-data handling for space satellite systems at Airborne Instruments Laboratory, a division of Cutler-Hammer.

William B. Harris: Formerly director of the Division of Environmental Sciences of the Atomic Energy Commission's Health and Safety Laboratory, has left the laboratory to become a consultant in environmental health, specializing in problems involving the control of beryllium dust.

Donald G. Fink: Appointed vice president for research of Philco Corp., Philadelphia. Previously Fink served as director of research and general manager of the Research Division.

James M. Jans: Former assistant chief engineer, promoted to chief engineer of Allied Chemical's General Chemical Division, Camden, N.J. Appointees to newly-created positions on the staff are: **Robert G. Bierbower,** manager of engineering administration; **John L. Ciba,** manager of design engineering; **Charles W. Gaylord,** manager of process engineering; and **James Jaffe,** manager of process engineering.

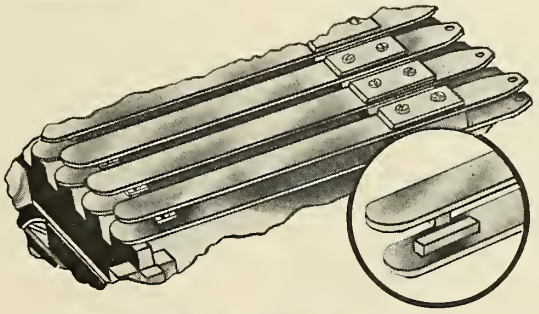
Dr. Zachary D. Sheldon: Former manager, Advanced Materials Development, General Engineering Laboratory, General Electric Co., joins the Carborundum Co. as associate director of the Research and Development Division.

W. J. Flanagan: Appointed materiel manager of the Glendale Branch of Librascope Division, General Precision, Inc. Before joining Librascope, Flanagan was general manager of Pacific Automation Products.

Dr. Walter Welkowitz: Named general manager of the Instrumentation Division of Gulton Industries, Inc., Metuchen, N.J., succeeding **Robert G. Day,** recently appointed to head the company's expanded activities in electro-optical-scanning systems. Dr. Welkowitz will continue to manage operations of Gulton's R&D Lab.

Dr. Bernd Ross: Developer of the world's first commercial silicon solar cell, rejoins Semiconductor Division of Hoffman Electronics Corp., El Monte, Calif., as manager of the solar development section and assistant technical director.

Dr. Vincent Berinati: Flight systems designer, named technical assistant to the director of Aerospace Corp., Washington, D.C. Dr. Berinati previously has worked for the Advance Research Projects Agency as a member of the Institute for Defense Analyses. At the Institute, he was assistant head of the space branch dealing with communication and navigation satellites as well as re-entry systems.



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contracts

NASA

$2,500,000—**McDonnell Aircraft Corp.**, letter contract for six Mark II Project *Mercury* spacecraft.

Astronautics Division of Chance Vought, Dallas, for development and fabrication of seamless elbows for the fuel system of the *Saturn* rocket. No amount disclosed.

Northrop Corp., Norair Div., Hawthorne, Calif., from Lewis Research Center for a study of behavior of liquids in zero gravity. No amount disclosed.

NAVY

$33,400,000—**Sperry Gyroscope Co.**, Great Neck, N.Y., from BuWeps, for automatic missile guidance radar systems used in the *Terrier* missile program.

$27,130,000—**Westinghouse Electric Corp.**, Pittsburgh, for nuclear reactor components for fleet ballistic missile submarines.

$26,639,600—**General Electric Co. Machinery Apparatus Operation**, Schenectady, for design and furnishing of five sets of all components which comprise various systems, except nuclear reactor.

$1,438,000—**Alpha Corp. of Texas**, Richardson, for design of an electronic system for guided missile frigate.

$889,283—**Servonics, Incorporated**, Alexandria, Va., for AN/SPS-T2A radar simulators.

$758,000—**Electric Boat Div., General Dynamics**, Groton, Conn., for design of an electronic system for nuclear-powered submarine.

$320,000—**Electrosolids Corp.**, Van Nuys, Calif., from BuShips, for design and production of static inverters for *Polaris* submarines.

$153,700—**Ryan Aeronautical Co.**, San Diego, for furnishing 13 man-months of factory-trained Q-2C field service engineers to each of three naval activities.

$112,348—**Textron, Inc., Dalmo Victor Co. Div.**, Belmont, Calif., for AN/PQS-1 sonar detecting set.

ARMY

$4,589,091—**Aerojet-General Corp.**, Covina, Calif., for construction of a *Saturn* static test facility at Redstone Arsenal.

$3,800,000—**General Electric Co.**, Burlington, Vt., from Boston Ordnance District, for 20 mm Vulcan guns.

$1,964,590—**Stanford Research Institute**, Menlo Park, Calif., for 3-year research and evaluation simulating effects of ionospheric variations on military high-frequency communications systems. Work to be done in Alaska, Thule, Greenland and Menlo Park.

$1,948,004—**B-E-C-K Constructors**, Seattle, for tropospheric communications facility at Barter Island AFS, Alaska.

$1,095,800—**Ghemm Co., Inc.**, Anchorage, Alaska, for tropospheric communications facility, Ft. Yukon.

$898,806—**General Instrument Corp.**, Newark, N.J., for AN/AMT-6C radiosonde set.

$500,000—**U.S. Steel Corp.**, Los Angeles, for rocket motor parts.

$441,256—**Valley Construction Co.**, Columbus, Miss., for construction of SAC guided air missile facility at Turner AFB.

$404,714—**Nor-Pac Corp.**, Grand Forks, N.D., for construction of SAC missile facility, Ellsworth AFB.

$388,369—**Altermatt and Frederick, Inc.**, Novato, Calif., for plug valves with auxiliary equipment for *Titan II* missile launch facilities.

$308,675—**Hendrick Construction Co., Inc.**, Richmond, Va., for construction of FD radar facilities, Manassas AFS.

$292,649—**Sperry Rand Corp.**, Salt Lake City, for repair parts and ground handling and test equipment for the *Sergeant* guided missile system. (Four contracts.)

$216,000—**Erbentraut & Summers**, San Francisco, for *Nike-Hercules*, improved with Hipar, at Travis AFB Defense Area.

$188,426—**Annin Co., Div. of Worthington Corp.**, Montebello, Calif., for butterfly valves with auxiliary equipment for *Titan* missile launch facilities.

$181,245—**Healy Tibbitts Construction Co. and Granite Construction Co.**, San Francisco, for *Nike-Hercules*, improved with Hipar, at Travis AFB Defense Area.

$246,000—**Canoro & Birklid**, Fairbanks, Alaska, for radar tower, Bethel AFS.

$137,376—**Douglas Aircraft Co.**, Santa Monica, for field change kits and repair parts for *Nike-Ajax, Hercules*.

$128,602—**Raytheon Co.**, Waltham, Mass., for replenishment spare parts for the *Hawk* missile system.

AIR FORCE

$35,800,000—**Philco Corp.**, Philadelphia, for continued development of command and control subsystems for space and satellite programs.

$7,000,000—**Special Systems Div., Minneapolis-Honeywell from GD/Astronautics**, for ground support equipment for the *Atlas* missile "F" series.

$750,000—**United ElectroDynamics Inc.**, Pasadena, Calif., from **Boeing's Aerospace Div.**, for *Minuteman* telemetry systems and ground support equipment.

$407,055—**The Magnavox Co.**, Ft. Wayne, Ind., for radio set AN/ARC-34, spare parts, aerospace ground equipment and data.

$396,000—**Univ. of Texas**, Austin, for research and reports on effects of ionizing radiation on biological, physiological and psychological functions of various species.

$365,328—**Instrument Corp. of Fla.**, Melbourne, for mobile ballistic camera system.

$306,366—**Dynatronics, Inc.**, Orlando, Fla., for modification of TLM-18 antenna system.

$250,000—**Kin Tel Div. of Cohu Electronics, Inc.**, San Diego, for television systems for *Titan* operational silo missiles at Vandenberg AFB.

$215,000—**Ramo-Wooldridge Div. of Thompson Ramo Wooldridge, Inc.**, Canoga Park, Calif., add-on for automatic data processing system test facility.

$108,336—**Pneumo Dynamics Corp., Instrumentation & Control Div.**, Grand Rapids, Mich., for rate gyro transmitters, spare parts, aerospace ground equipment and related data.

$100,000—**Telecomputing Corp., Power Sources Div.**, Denver, from **North American's Autonetics Div.**, for further development of batteries used with *Minuteman* inertial guidance and flight control systems.

DEPT. OF DEFENSE

$5,500,000—From the Defense Atomic Support agency for the design and development of an interservice Damage Assessment Center, as follows: $3,000,000—**System Development Corp.**, Santa Monica, Calif., for computer model development and programing; $1,500,000—**Control Data Corp.**, Minneapolis, for computer system; $1,000,000—**Ramo-Wooldridge Div. of Thompson-Ramo-Wooldridge Corp.**, Los Angeles, for display system.

reviews

PRINCIPLES OF INERTIAL NAVIGATION, C. J. Savant, Jr., R. C. Howard, C. B. Solloway and C. A. Savant, McGraw-Hill Book Co., Inc., New York, 254 pp., $9.75.

This book is for the design engineer working on inertial navigation problems. The authors were handicapped because much of the literature in the field is classified; but even under this limitation, the book covers basic principles adequately—even if in some instances irregularly. By this we mean that in the same discussion that some general technical principles are covered, there sometimes appear trivia, such as the weights and volumes of some of the black boxes—for example, "The electronic equipment assembly includes 10 modular-type plug-in chassis which together occupy a volume of 1800 cu. in.," and so on.

For a reader who can overlook these occasional lapses, the book is recommended. It covers three areas: first, the basic concepts of navigation and the elements required for automatic navigation (for readers with not too much specific knowledge in this area); second, for design engineers, the auto-navigation components and computers, platform controllers, ground alinement and pre-flight testing; third, the theoretical basis of the subject.

THE MILKY WAY GALAXY—Man's Exploration of the Stars, Ben Bova, Holt, Rinehart and Winston, Inc., New York, 229 pp., $5.

The author is a journalist who was trained on *Vanguard* and later went on to Technical Operations, Inc. Hence he combines literary ability to present his subject clearly with technical understanding.

The book is indeed for the lay reader, and not designed to interest anyone else. It gives some of the lore of astronomy and summarizes some of the more popular concepts of the creation and characteristics of the universe.

MODERN FLIGHT DYNAMICS, W. Richard Kolk, Prentice-Hall, Inc., Englewood Cliffs, N.J., 288 pp., $10.

Here is a highly recommended book for the aeronautical and missile engineer working on dynamic stability problems. The presentation is straightforward, practical and presented in the classical way—the author being a systems engineer at United Aircraft Corp.—that first appeared and was developed by the old NACA.

Kolk begins with a treatment of Newton's Second Law and Lagrange's Equation as alternative ways of formulating the equations of motion. Then he introduces direction cosines and Eulerian angles for the purpose of orientation reference. These two introductory techniques are the tools with which he then analyzes the dynamics of flight vehicles.

In dealing with aerodynamic quantities, the author does not reduce the equations of motion to non-dimensional terms, as is usually done. Instead, he treats all motions as true ones and seconds as constant quantities—not varying with speed, altitude and wing loading.

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MAY

Institute of Radio Engineers, Professional Group on Microwave Theory and Techniques, National Symposium, Sheraton Park Hotel, Washington, D.C., May 15-17.

Society of Aeronautical Weight Engineers, National Conference, Sheraton Hotel, Akron, Ohio, May 15-18.

ARS National Telemetering Conference, Sheraton Towers Hotel, Chicago, May 22-24.

Fifth Global Communication Symposium (Globecom V) and National Telemetering Conference, sponsored by American Institute of Electrical Engineers, Institute of Radio Engineers, Institute of the Aerospace Science and Instrument Society of America, Sherman Hotel, Chicago, May 22-24.

Design Engineering Show, Cobo Hall, Detroit, May 22-25.

Society of Automotive Engineers, Military Ground Support Equipment Committee, Continental Hilton Hotel, Mexico City, Mexico, May 23-25.

Operations Research Society of America, Ninth Annual Meeting, Sheraton-Blackstone Hotel, Chicago, May 25-26.

First National Conference on Peaceful Uses of Space, sponsored by National Aeronautics and Space Administration and the Tulsa Chamber of Commerce, Tulsa State Fairgrounds, Tulsa, Okla., May 26-27.

Chemical Institute of Canada, Forty-fourth Annual Meeting, Ottawa, Canada, May 29-31.

7th Annual Radar Symposium (SECRET), University of Michigan, Institute of Science and Technology, Ann Arbor, May 31-June 2.

JUNE

National Machine Tool Builders' Association, 59th Spring Meeting, Mayflower Hotel, Washington, D.C., June 1.

American Society for Quality Control, Annual Convention, Sheraton Hotel, Philadelphia, June 5-7.

International Instrument Automation Conference and Exhibit, Instrument Society of America, Royal York Hotel, Toronto, Canada, June 5-8.

National Electrical Manufacturers Association, Western Conference, Biltmore Hotel, Los Angeles, June 8-9.

Manufacturing Chemists Association, 89th Annual Meeting, The Greenbrier, White Sulphur Springs, W.Va., June 8-10.

European Federation of Chemical Engineering, Thirtieth Meeting, Frankfurt-am-Main, Germany, June 9-17.

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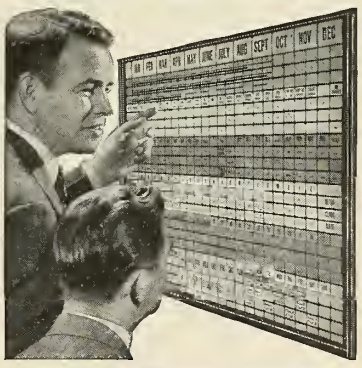
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editorial . . .

Like It Comes Up A Seven

THANK GOD, he made it.

Cmdr. Shepherd's demonstration of personal courage and devotion to country lifts the hearts of all Americans. His modest, realistic appraisal of his achievement makes all of us proud of him.

All those in the missile/space industry who took part in the program can feel a genuine sense of achievement at the technical advances which contributed to the success of the suborbital *Mercury* flight. And the blaze of publicity in which the flight was carried out stands in shining contrast to the secrecy which shrouded the Russian shot.

The Administration and the public relations officers of NASA have scored a tremendous propaganda triumph as a result of the open stage on which Shepherd's flight took place. As a result of this, many people throughout the world feel we have caught up with the Russians in the space race. The tremendous gamble which was taken paid off. No one is more delighted than we are.

But the fact that it succeeded doesn't mean it was right.

We are reminded of the man who goes into the Las Vegas gambling hall, puts all his money on No. 7 and wins. "Look," he shouts, "I won. I knew exactly what I was doing."

It is faulty logic. His chances of winning were extremely small. And if he bets all his money on No. 7 again, he is quite likely in for a rude awakening.

The President, in fact, has acknowledged the risk taken. At his May 5 press conference, he stated: "I agree that if it had failed, having had some experience with that, it would be a very difficult time for NASA and for us all. But fortunately, it succeeded."

Fortunately.

The President went on to imply that the Administration had not tried to build up the shot but had merely responded to pressure from the press.

With all due respect, we've been in this business too long to buy that. When open invitations are sent to the Hill, when unembargoed press kits are distributed many days in advance, when TV networks are given the run of the Cape days in advance, when contractor parties are not discouraged, when the press is polled weeks ahead of time on its requirements—that's a buildup, Mr. President.

Mr. Kennedy went on to state that "our failures are going to be publicized as well as our successes and there isn't anything that anyone can do about it or should."

RESPECTFULLY, we also must take issue with that. Something can be done about it. It can be done by preventing the tremendous advance publicity buildup which would have made the *Mercury* shot such a worldwide propaganda defeat if it had ended in flaming disaster on the Canaveral pad.

Our failures and successes must be fully reported. But let us do away with the advance drum-beating which can magnify the failures. In many years of covering the aviation and missile/space industries, we have attended many first flights and missile shots under an embargo on advance copy.

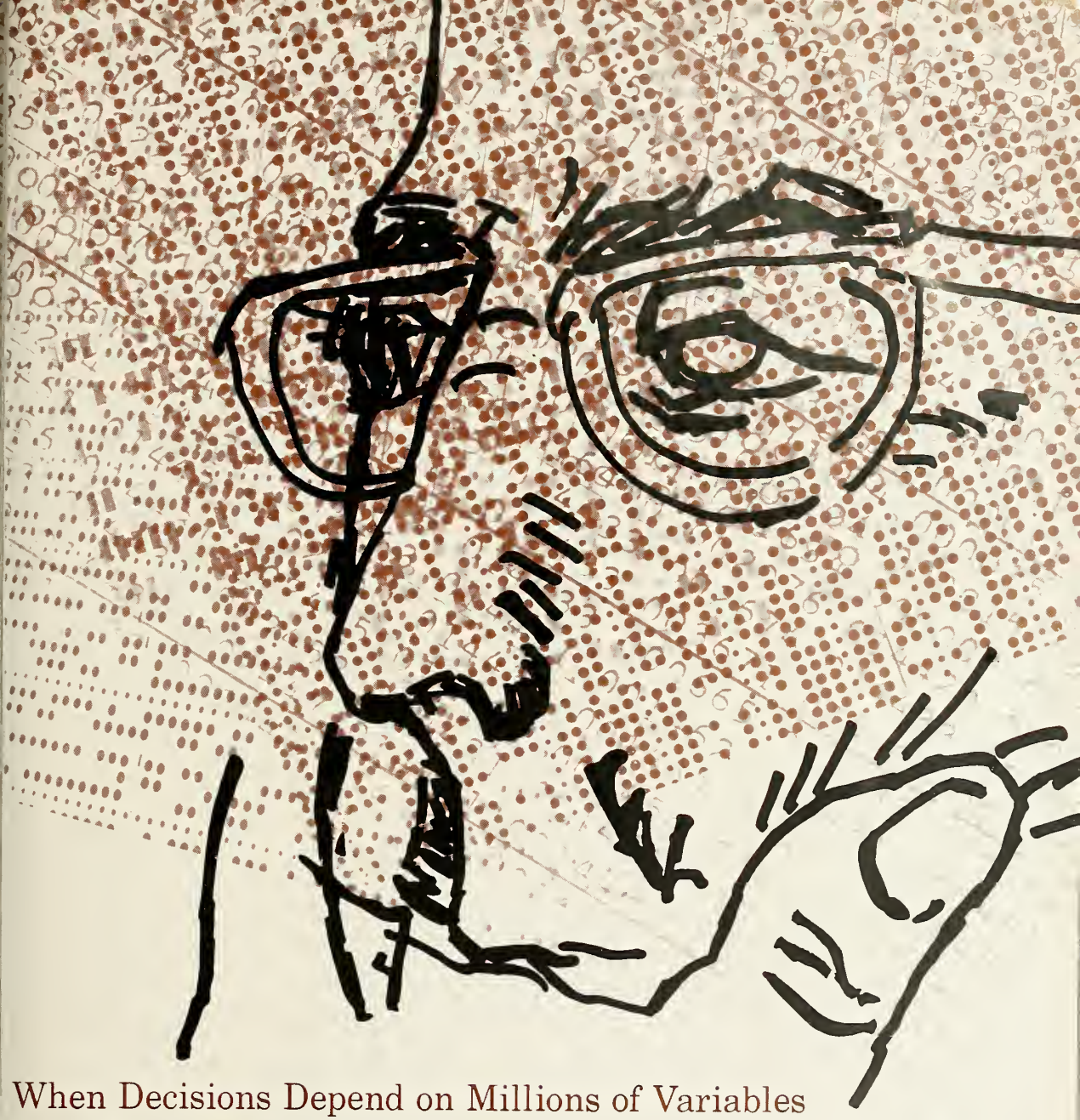
Many responsible reporters at the Cape felt this procedure could, and should, have been followed on the suborbital *Mercury* shot.

We are among those who in the past have urged the Administration to gamble some money on unproved projects which have a chance of paying off. But in this case, the worldwide prestige of the United States was needlessly gambled on the *Mercury* shot. The stakes were too high, the risk to great. Let us emphasize the word again: NEEDLESSLY.

Nothing succeeds like success. But we hope the success won't prevent a careful evaluation of the terrible risk we ran.

William J. Coughlin

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When Decisions Depend on Millions of Variables

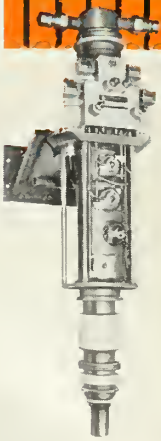
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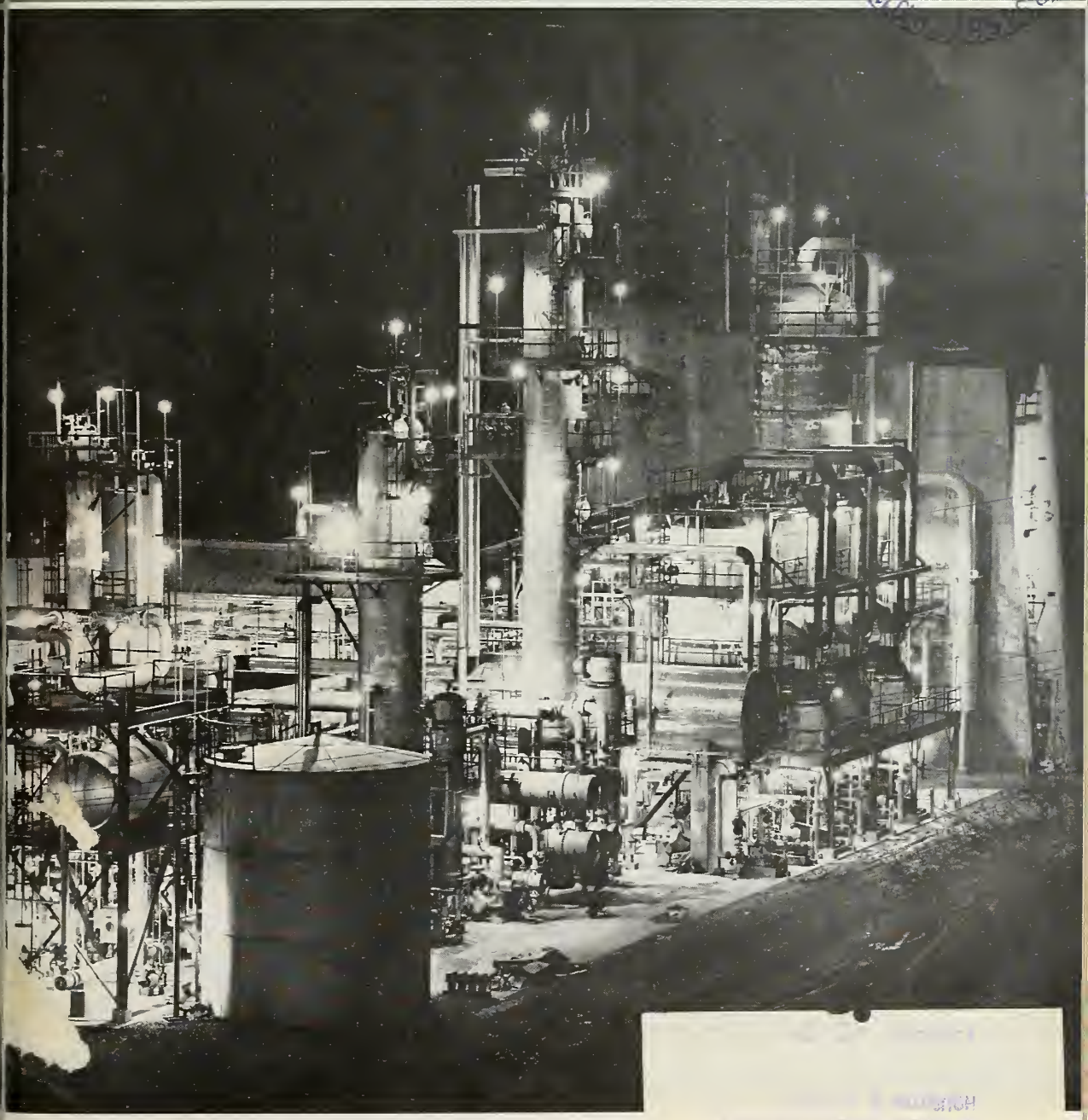
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MAY 22, 1961

missiles and rockets

THE MISSILE/SPACE WEEKLY

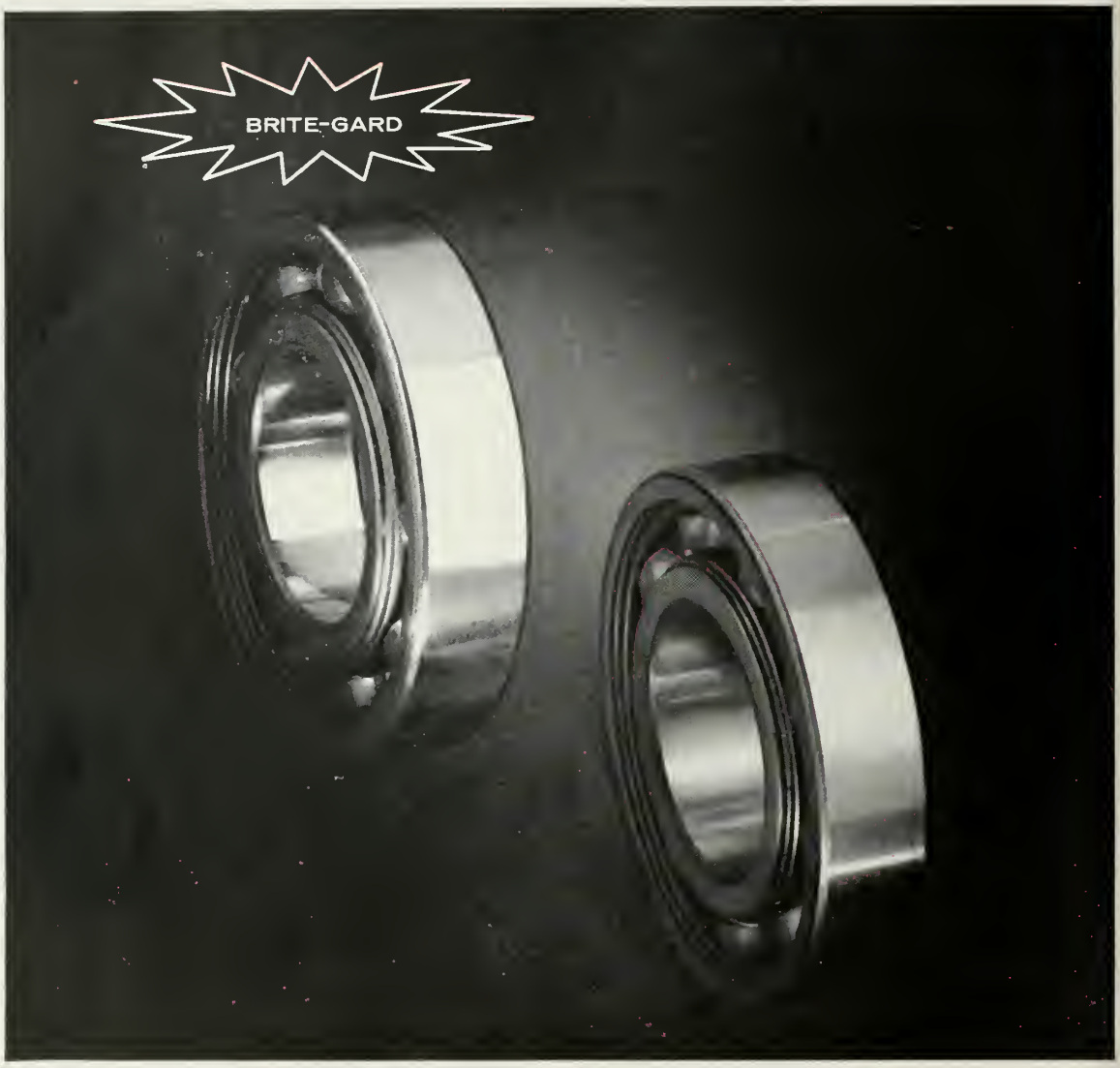
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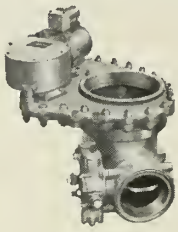
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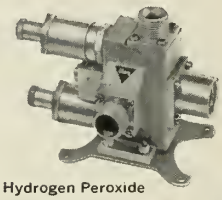
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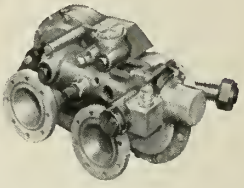
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(Hound Dog Missile)



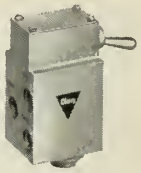
Hand Loader
(Jupiter Missile)



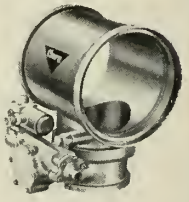
Drain Valve
(C-130 Transport)



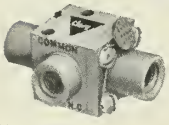
Restricter Valve
(F-100 Interceptor)



Toggle Valve
(Hound Dog Missile)



LOX Fill & Drain Valve
(Titan Missile)

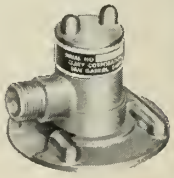


Shuttle Valve
(Jupiter Missile)

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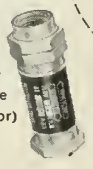
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(C-130 Transport)



Fuel Drain Valve
(Electra Airliner)



Pressure Regulator
(F-100 Interceptor)



One-Way
Restricter Valve
(F-100 Interceptor)



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(Jet Star Transport)



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(Constellation Airliner)



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(F-104 Interceptor)



Vacuum & Relief Valve
(Firebee Drone)



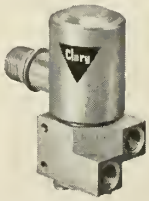
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(A3J Vigilante)



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THE MISSILE / SPACE WEEKLY

missiles and rockets

Volume 8, Number 21 May 22, 1961

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THE COVER

Largest anhydrous hydrazine plant in the world is now on stream in Saltville, Va. The heavily automated facility will supply fuel for Titan II and Dyna-Soar. See p. 18.

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† U.S. Reg. Pdg.

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MR-3 Publicity Debated

To the Editor:

A pat on the back for your May 8 editorial, "The Debacle at Cape Canaveral." Of all the editorials that have sprung from the *Mercury* shot, yours was the only one with guts enough to lay it on the line.

In my opinion the people who gained the most from this "lob" downrange were (a) The motels along A-1-A with their full complement of newsmen, home town senators and congressmen; (b) AT&T, Western Union, with their leased wire service—transmitting millions of words to the outside world in regard to what Commander Shepard had for lunch and the local weather report; (c) I would guess the biggest benefit was derived by the vending machines and the chow wagons used to service newsmen waiting for the shot at the grandstand on the Cape.

I just hope your and Senator Williams' advice will be considered on the orbit shot scheduled to come later. However, I doubt it. I would guess they have souvenir pennants all ready—just silk-screen the date, and they will sell like hot cakes, along with the hot dogs, popcorn and cokes.

Robert J. Hughes
Perry-Brown, Inc.
(ex-*Vanguard* Info Team)
Cincinnati

To the Editor:

May I speak personally rather than as a representative of my company? I have just finished reading your editorial, "The Debacle at Cape Canaveral." Happily, the news reports coming in this week from all of the nation's press are proving your editorial to be completely wrong. Apparently world opinion has swung to our side and we actually now have the Russians on the defensive from a propaganda standpoint because of the secrecy of their flight.

Most certainly the flight has proved to have had considerable prestige value and, if my interpretation of what I have read is correct, it also had some scientific value and in effect was a necessary first step to further progress in our space program.

The entire United States felt a great sense of pride in the open and free way our flight was publicized. They also felt a great sense of identity with Commander Shepard.

With major highways running by the Cape, with motels having views of the rockets on their pads, it is difficult for me to see how such an event could be kept secret.

You will pardon me if I consider the words "nauseous," "worst possible taste," "appalling display of ignorance," "buried in an emotional frenzy," "debacle," and "revolting display" hard to take for any of the many thousands of people who have worked so hard to make Project *Mercury* successful.

Dean B. Randall
Minneapolis-Honeywell Regulator Co.
Minneapolis

To the Editor:

In the light of Alan Shepard's high ride to glory, it would be hard to sit down and figure out a more unfortunate headline than you put on your May 8 editorial. However, it is not my intention to belabor you with 20-20 hindsight. My point in writing is this: the *one* thing we *did* have, as it fortunately turned out, which really put the Russians in the shade, was the very thing you were afraid of—the risk, taken in full view of the world. Gagarin might have been Astronaut Number Twenty, for all we know. Or they might have blasted one around, landed it, and planted Gagarin in it after the landing for the cameras.

I *do* think Shepard's ride was more dramatic than anything I have ever seen—that it was handled superbly by the TV boys—that it galvanized this nation (it certainly did me) as no after-the-fact account possibly could. And I further feel that we ought not to follow the secrecy of the Soviets—even if we blow some poor guy to bits on the pad. America is running second—in space, at least—and while you are correct in saying that big public failures are terrible publicity, still, isn't this the strength *and* the weakness of our whole system?

Again, please don't think I'm carping at your editorial. If Shepard had been killed, you'd have had a scoop. I know we are both glad you did not.

Frank Harvey
Hackettstown, N. J.

To the Editor:

The editorial is the meanest and most shameful criticism and ridicule of a great American hero ever printed. This reads like communism, so please cancel my subscription.

Dewey Thompson
Washington

To the Editor:

Without question, Mr. Coughlin. . . .

Your editorial is a beaut! We're not surprised to find the sentiments you expressed in MISSILE AND ROCKETS; it takes an editorial and a publishing staff with wisdom and courage to put into black and white the thoughts that many of us have nourished privately. This one editorial alone is worth the price of the subscriptions!

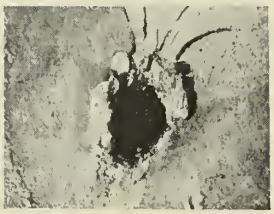
Lucien R. Greif
Greif Associates, Inc.
New York

To the Editor:

Your editorial, with its clichés and witticisms, was not in character with your fine publication. You state that yours is







SS.10 SS.11
Anti tank missiles
designed and manufactured by
NORD-AVIATION 2 a 18, RUE BÉRANGER CHATILLON s/s BAGNEUX SEINE - TEL. ALESIA 57-40

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not to question the courage and dedication of the Project *Mercury* team, but to question the wisdom of the public relations approach to the shot. If this is true, why do you call this suborbital launch a "Circus Stunt," a "Roman Spectacle," a "Debacle," a "Human Cannon-Ball" fired before the eyes of horrified paying customers?

Sure there was an element of risk, but isn't this always true in exploration? I was not nauseated by this "revolting" display, I was proud. Proud and humble at the same time, realizing that this was the culmination of many, many man-hours of hard work and the answer to unnumbered prayers.

I suggest that to have handled the publicity in any other manner would have had a tendency to discredit the effort as a whole. The world has been impressed with two cogent facts: (1) We did send a man into space and successfully recover him with no apparent ill effects and (2) a human life is still the most important commodity in the U.S.

We learn from our failures and we are proud of our successes.

T. W. Wissore
Chesterfield, Mo.

To the Editor:

I do not share the view expressed in your very critical editorial. Bold action was required to get the most favorable world reaction to what was admittedly a minor feat compared to Major Gagarin's flight. It was a gamble which in my opinion was well taken and which paid off.

If the flight had failed, a critical editorial would probably have drawn assent from many readers. I admire your courage in presenting the negative view . . .

H. F. Mayer
Manager, Advanced Electronics Center
General Electric Co.
Ithaca, N.Y.

To the Editor:

A California orchid to Bill Coughlin for the perspicacity and courage that impelled him to publish the only forthright editorial on the subject of "the debacle at Cape Canaveral" that I have read anywhere—and I have done some looking.

I would like to go on for several paragraphs venting my own views on that pathetic vaudeville performance, but Bill wrote it better and with gentlemanly restraint, so I will choke off my own choler.

I am having the piece copied and sending it out to encourage some friends in public places to think with their thinkers instead of their feelers.

Bert W. Holloway
Corporate Director
Advertising, Publicity, Promotion
Lockheed Aircraft Corp.
Burbank, Calif.

Telling the People

To the Editor:

Re your editorial (M/R, May 1), "The People Wait to be Told."

Amen!

Harrison A. Lehmann
Major, USAF
Eau Gallie, Fla.



More than 40,000 parts, each of which must meet the most stringent reliability standards, make up the U. S. *Atlas* intercontinental ballistic missile, built by prime contractor Convair (Astronautics) Division, General Dynamics Corporation.

Among these parts is the Bristol Syncroverter* chopper . . . adding to its record of service in U. S. guided missile systems of almost every type since their very beginnings.

Billions of operations. To insure the reliability so necessary in aircraft and missile operations, Bristol Syncroverter choppers are constantly under test at Bristol, with and without contact load. One example: We've had five 400-cycle choppers operating with 12v, 1ma. resistive contact load, for more than 26,000 hours (2.96 years) *continuously* without failure—over 37-billion operations!

Many variations of Bristol Syncroverter choppers and high-speed relays are available—including external-coil, low-noise choppers. Write for full data. The Bristol Company, Aircraft Equipment Division, 173 Bristol Road, Waterbury 20, Conn.



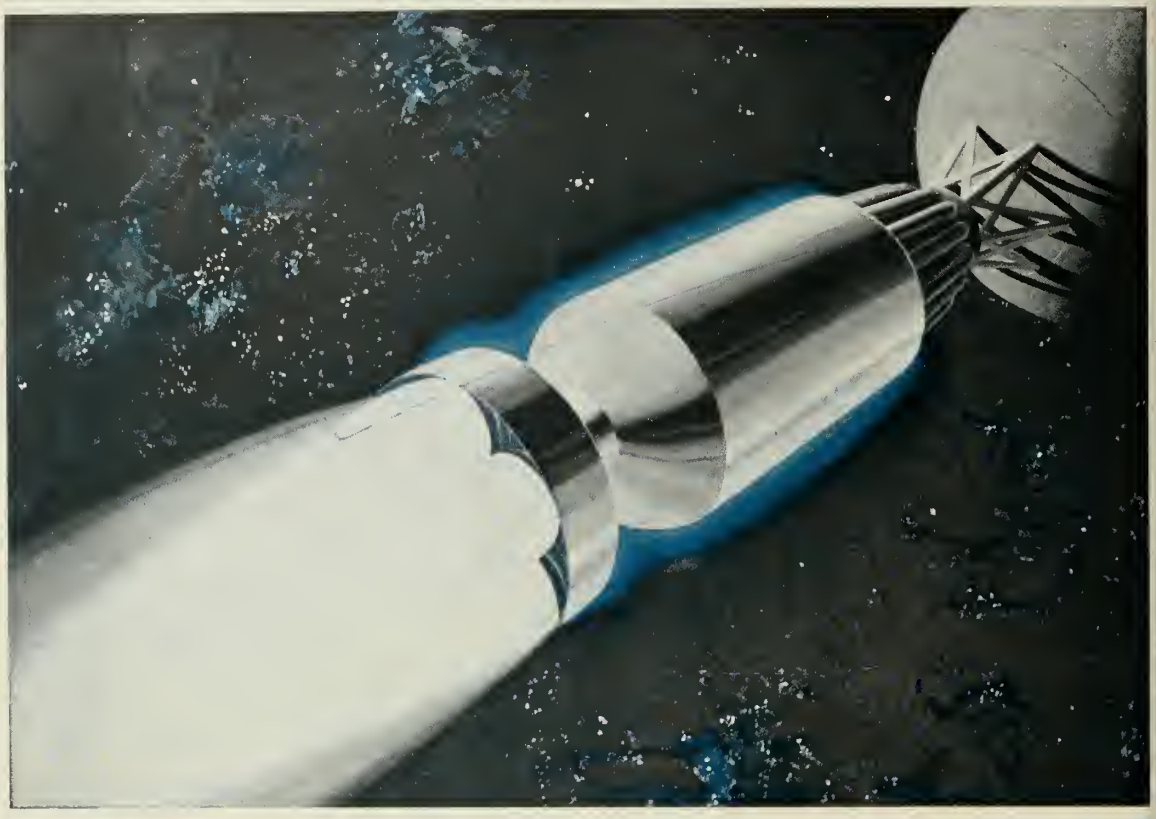
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.09 **T. M. Reg. U. S. Pat. Off.*

BRISTOL FINE PRECISION INSTRUMENTS FOR OVER SEVENTY YEARS

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NUCLEAR ROCKET PROPULSION AT AEROJET-GENERAL



Nuclear rockets, with a performance capability nearly twice that of the highest-specific-impulse chemical rockets, have been of major interest to Aerojet-General for several years.

Exploratory studies were initiated by Aerojet in 1955 to ascertain the feasibility of nuclear rockets, and the technical advances required to develop a successful nuclear propulsion system were determined. This work at Aerojet has undergone continuous expansion under government and company sponsored programs. Included are: preliminary design of engines and vehicles, simulated nuclear engine tests, radiation hazards research, analog computer system design (to simulate nuclear rocket operation), nuclear test facility construction, and the design, development, testing, and manufacture of reactors.

These programs have resulted in significant progress toward the development of a practical and reliable nuclear propulsion system. They are based on Aerojet's combined experience in liquid and solid propellant rocketry, nuclear technology, and cryogenics—experience which ensures that the challenge of a new era in propulsion can, and will, be met.

Aerojet-General® CORPORATION

THE GENERAL TIRE

A SUBSIDIARY OF THE GENERAL TIRE AND RUBBER COMPANY

The Countdown

WASHINGTON

Where the AF Missile Dollar Will Go . . .

The latest revision of the Air Force procurement program for missiles in FY '62 includes: $201.6 million for Convair *Atlases*; $1.13 billion for Martin *Titans*; $923.8 million for Boeing *Minutemen*; $131 million for North American *Hound Dogs;* and $16.3 million for Martin *Bullpups.*

And the Navy's . . .

The new Navy's FY '62 missile procurement program includes: $37.8 million for Raytheon *Sparrow III's*; $25.2 million for *Sidewinder 1-C's;* $45.3 million for Convair *Tartars*; $36.8 million for Bendix *Taloses*; $26.2 million for *Bullpups*; and $6.7 million for the initial buy of Goodyear *Subrocs.*

And the Army's . . .

The new Army FY '62 missile procurement program includes: $78 million for *Nike-Hercules* GSE; $127.7 million for Raytheon *Hawks;* $9.8 million for Nord *Entacs*; $16.7 million for Emerson Electric *Honest Johns*; $93 million for Sperry *Sergeants.*

New Polaris Increase Voted Down

The House Armed Services Committee voted down in closed session a committee member's proposal to add six more *Polaris* subs to the 10 included by President Kennedy in the FY '62 defense budget. The Kennedy request would bring the total number of *Polaris* submarines authorized by Congress to 29. The additional six were proposed to enable the Navy to build more long-leadtime items—and to tentatively commit the Administration to building more than 29 *Polaris* subs. The committee vote: 25 to 3.

The Coming Boost for Boosters

Both nuclear-powered and solid-propelled boosters are expected to receive a major push in President Kennedy's forthcoming request for greater space spending. Insiders predict the Air Force will be given the assignment to develop a large segmented solid booster; NASA and the AEC will continue work on *Rover.* This would be the first major switch in booster assignment since NASA was given the National Booster Program.

Total Subroc Buy Disclosed

The Navy has revealed that it plans to spend a total of $100 million on the new *Subroc* ASW missile. The nuclear-tipped Goodyear missile is expected to be deployed for the first time this year, greatly extending the striking range of U.S. hunter-killer submarines.

Weather Satellite Net: Coming Soon

The Kennedy Administration is expected to put more money behind development of a weather satellite network that possibly could be in operation by mid-1962. Under plans now being discussed, the Weather Bureau would have operational control; NASA would provide the satellites and boosters and direct satellite launchings.

INDUSTRY

New ICBM Contract Probe Under Way

The House Armed Services Investigating Subcommittee is digging into charges that bid "procuring" is again infecting the ICBM base-construction program. This time the first *Minuteman* complex in Montana is involved. Allegedly two Los Angeles firms—George A. Fuller and Del E. Webb Corp.—received a $61-million contract and proceeded to subcontract almost all of it. Then, allegedly, almost all of the subcontractors proceeded to do the same.

R&D Intelligence

AEC is talking again about the possibility of flight-testing a *Rover* nuclear rocket engine by 1965—if all technical milestones are reached. . . . MIT's National Magnet Laboratory will be equipped with air-core magnets developing 250,000 gauss, a half-million times greater than the earth's magnetic field. General Electric is supplying the power sets (8000 kw) under a $1-million contract. . . . AOMC is building a new test facility at Huntsville to captive-fire *Nike-Zeus* and other solid missiles.

Titan II First Flight Now '62

COUNTDOWN is told the first flight of the storable *Titan II* test is now expected to slip over into early 1962. The official schedule has a date late this year.

C-W Moving Into Missile/Space Field

Curtis-Wright Corp. is beefing up its electronic and nuclear capability—apparently in preparation for a major corporate move into the missile/space industry. C-W has just purchased Abrams Instrument Corp. (electronics) and set up a new subsidiary, Advanced Miniaturized Electronics Inc. It also has bought into Target Rock Corp., a nuclear power component maker.

Big Atlas-Agena B Buy Forecast

Grand Central Rocket Co. estimates predict the Air Force will buy 265 *Atlas-Agena B's* in the next 10 years for four satellite programs alone. The GCR count: 84 for *Samos,* 56 for *Saint,* 83 for *Midas* and 42 for *Bambi.*

INTERNATIONAL

Overseas Pipeline

Russia is expected in some quarters to launch another spacecraft soon—this time with two men inside. . . . Canada is interested in buying *Bomarc B* antiaircraft missiles armed with nuclear warheads. . . . Insiders are wondering why the Red Chinese are taking so long to touch off their first nuclear device. It was expected earlier this year. There is a possibility the Russians prevailed upon them to postpone the shot to strengthen the case for the United States to pressure the French into curtailing their A-tests.

Turkey Talk on Blue Water

British Defense Minister Harold Watkinson is understood to be talking turkey with the West Germans about the merits of buying the British *Blue Water* rather than the U.S. *Sergeant.*

SUPPORT FOR THE SPACE AGE

Since the early days of "wireless" Blaw-Knox has been designing, fabricating and erecting towers and special structures to support equipment used to penetrate space. This long experience with the problems involved in this field is the reason systems companies and governmental agencies continue to utilize Blaw-Knox specialized facilities.

Call Blaw-Knox early in the planning stages for consultation and assistance on the design and fabrication of either prototype or production items. Blaw-Knox Company, Pittsburgh 38, Pennsylvania.

SPECIAL STRUCTURES AND TOWERS FOR TRACKING, PROBING, SEARCHING, COMMUNICATION EQUIPMENT

BLAW-KNOX

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Special Structures

The Missile/Space Week

Moon Investigation Sought

A member of the House Space Committee has called for a congressional investigation into the scientific and strategic importance of the moon.

Rep. David S. King (D-Utah) urged the inquiry in a letter to Committee Chairman Overton Brooks on the grounds that "neither Congress nor the American public fully understands the importance of beating the Russians to the moon."

Meantime, the committee released a staff study contending that military needs in space are being shortchanged.

The study—written last December—urged the creation of a top-level management agency under the National Space Council. It also urged the creation of a military applications division within the National Aeronautics and Space Administration.

Grind for Astronauts

A six-month course at the Air Force's new space pilot school could be the most grueling in an aspiring astronaut's life.

Enrollees, already graduates of the eight-month Experimental Flight Test Pilot School Course, must master Newtonian mechanics, thermodynamics, fluid mechanics, boundary layer theory, high-speed aerodynamics, heat transfer, dynamics of rarified gases, Einstein's theory of relativity, meteorology, astronomy, propulsion, orbital mechanics, trajectories and other subjects.

Several T-38's and F-104's will be modified to provide spacecraft flight characteristics. AFSC is also considering modifying an *X-15* to make a two-seat trainer. The school will be conducted at the Air Force Flight Test Center, Edwards AFB, Calif.

S-II Deadline Nears

Seven companies are still in the running for the prime contract on the *Saturn S-II* stage, which will be the largest rocket ever built by private industry, at a total cost of $220 to $240 million.

Aerojet-General, Chrysler Missile Division, Convair/Astronautics, Douglas, Lockheed Georgia Division, Martin-Baltimore and North American-Los Angeles filed preliminary proposals with the National Aeronautics and Space Administration earlier this month.

In about two weeks, NASA's Marshall Space Flight Center will invite some or all of the seven to submit detailed bids with cost information. The deadline has not yet been set. The bids will be evaluated in time to award the contract soon after the July 1 beginning of the new fiscal year.

President Kennedy has ordered NASA to move at top speed starting work on the *S-II,* which will be the second stage of *Saturn C-2,* the launch vehicle designed for manned circumlunar flight.

Atlas Boosters Modified

Atlas boosters to be used for the unmanned and manned Project *Mercury* orbital flights are "ready to go" as far as modifications are concerned. Convair/Astronautics spokesmen say



Moon Soft-Lander?

700-LB. rocket-powered vehicle developed by Navy can reverse thrust and land softly. NOTS engine has 1300-lb. thrust.

the programer trouble blamed for the last *Atlas* launch failure has been corrected with "several design changes" now undergoing checkout.

Karel J. Bossart, Convair/Astronautics technical director, said the major modification NASA originally asked for involved thickening of the nose section skin, "although we didn't think this was essential."

Bossart expressed concern over what he called recent erroneous newspaper reports that the *Atlas* booster was to blame for some launch failures. "The *Atlas* isn't entirely blameless," he said. "But it should be pointed out that some of the 'failures' were in the second-stage missile, not the booster."

Final Tests for SA-1

In about a week, the *SA-1 Saturn* flight booster will come down from the static test stand at Huntsville and go into quality control for final testing.

The booster passed its final static test May 11 in a 111-sec. firing. It will be in quality control for about 2½ months and then will be prepared for shipment to Cape Canaveral. Flight date is expected to be October.

The contractors will turn over the launch tower at the Cape to NASA on June 5.

Earth-Moon Transport Study

The Martin Co. will study an earth-lunar transportation system for NASA under a $75,000 contract with Marshall Space Flight Center.

The study will cover the problems of lunar landing and immediate return, a 30-day stay and a permanent lunar base.

Bouncing Off Venus

Russia has measured the astronomical unit at 149,457,000 kilometers (92.9 million miles) by radar reflection from Venus.

Tass quoted the USSR Academy of Sciences last week as reporting that the radar reflections showed the planet's period of rotation to be about 10 or 11 days.

In the United States, the Jet Propulsion Laboratory of the California Institute of Technology also made measurements by radar during Venus' recent close approach. However, the JPL results have not yet been reported.

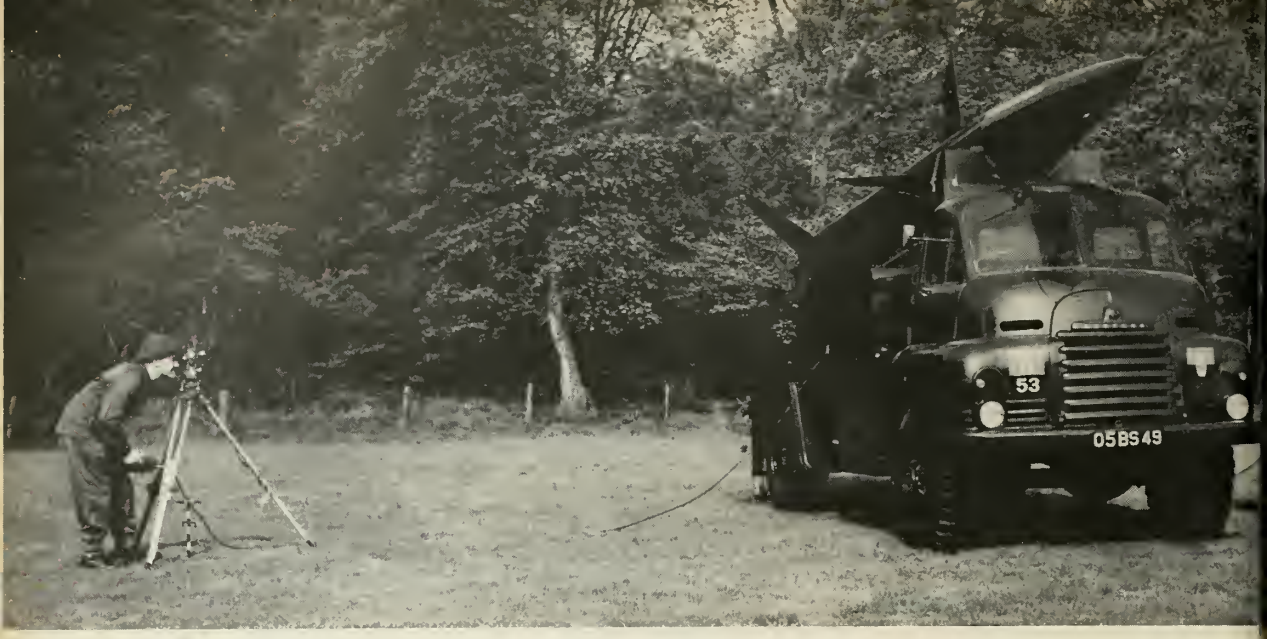


in telemetry systems management

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Blue Water unveiling . . .

British Push Tactical Missile

English Electric bird competes hard against Sperry's Sergeant, is main attraction among missiles at Paris Show

by Bernard Poirier

English Electric is publicly displaying its secret *Blue Water* missile for the first time this week in a stepped-up drive in the NATO nations to outsell the competing Sperry *Sergeant*.

The showing of the solid-propellant surface-to-surface *Blue Water* at the Paris Air Show comes as the Anglo-American sales fight reaches a new level of bitterness in diplomatic and British industry circles.

Meantime, the West German missile market appeared to be opening up. They are now in the process of buying the 350-mile *Pershing* and weighing purchases of other missiles.

West German Defense Minister Franz Josef Strauss stressed anew his belief in the need for a credible nuclear deterrent force in Europe and indicated strongly that West Germany might have to take new steps to maintain one.

Blue Water represents Britain's initial public bid to answer SACEUR's proposal to make "battlefield-type atomic weapons" available to battalion size NATO units of some 4000 men each.

• **Short countdown** — The *Blue Water* combat unit includes only a Bedford launcher and a Land Rover computer van. Miscellaneous equipment like the tripod theodolite, cables and manual controls are carried along with the crew in the vehicles.

The offer of a flexible and lethal weapon to NATO comes at a time when most military commanders agree with SACEUR's appraisal that in reasonable circumstances "the forces assigned to NATO require the support of nuclear weapons."

English Electric, a British Aircraft Corp. member, admits potential launching sites should be surveyed beforehand. Short 10 min. countdowns are possible when "the actual firing site has already been accurately surveyed." Reportedly NATO has surveyed all areas where enemy aggression could likely occur from the North Sea to the Adriatic.

The compact field unit is self-sufficient. It carries target information, computers, circuits and cables to activate guidance and firing sequences. The short firing time is possibly unequalled by any other known or admitted land system.

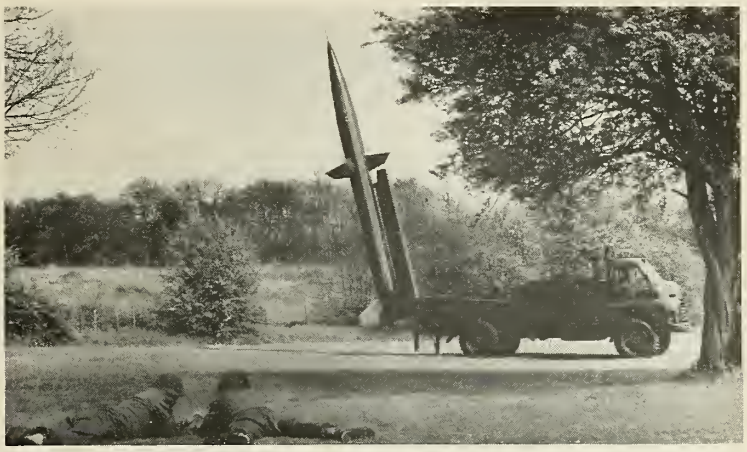
Relatively lightweight, the 25-ft. missile is carried on a 3-ton chassis. The missile carrier can remain hidden while the crew and computer van are at the site preparing for launch. The company suggests the interval from the time the crew reaches the launch site to the programmed air burst of the warhead is about 15 mins.

Pleased by evaluation tests over the last six months (believed to have been conducted at Woomera), they say no anomalies in solid motors were discovered after storage tests and that assigned missiles "can be kept for long periods of instant readiness."

• **70 mi. range reported**—Chief competitor to *Blue Water* is the American *Sergeant* manufactured by Sperry Utah Engineering Lab. Their ranges are believed to be comparable although the *Sergeant* is 11 ft. longer than its rival to replace *Corporal*. (M/R, Oct. 17, 1960, p. 41).

The British bid to offer a missile with nuclear capabilities to NATO could dissipate much of the political controversy that so far has stalled establishing NATO as the fifth nuclear





OPTICAL ALIGNMENT with theodolite of stable platform is done while Blue Water is in horizontal position. About 30 missiles have been test-fired. Model shown here is dummy of operational configuration, which is 25 ft. long.

Sales to NATO Nations

power. Standardization and agreement on this doctrine would serve to hone the NATO sword and increase credibility of its continental shield.

West Germany has been supporting the idea of NATO participation in sharing *Blue Water* T&E costs and possibly cutting its operational 1963 target date. Moreover, non-NATO member Sweden has officially expressed interest in the missile's dual purpose of conventional or atomic capability.

English Electric's entry into NATO competition appears strong as judged by details of combat countdown procedure which will be demonstrated in Paris by a British Army detachment from the Royal Artillery. This is the sequence:

• **T−13 mins.**—Computer van reaches the site and calculates reciprocal target bearing which is relayed to the theodolite operator who then positions directional markers for the launcher's driver.

• **T−12 mins.**—Launcher moves on site as computer in van refines azimuth and target bearing. Theodolite telescope is set at 90° to this bearing.

• **T−11 mins.**—Rear of launcher platform is levelled transversely with jack extensions.

• **T−10 mins.**—Computer van draws alongside for multicore cable connection with launcher fire control. Flight instructions and target selection are fed to missile guidance through relay.

• **T−8 mins.**—Unsecure transportation clamps. Release stable inertial platform in missile while crew extends firing cable away from launcher to command area.

• **T−6 mins.**—Check-out firing and guidance circuits while nozzle and ignitor is attached.

• **T−4 mins.**—The theodolite operator, looking through the theodolite into a window in the skin of the missile, uses a remote control box to align the stabilized platform and nul any drift.

• **T−2 mins.**—All gear except fire cable and firing switch unit is packed away. The officer activates the warhead safety switch and joins an enlisted man who readies the firing circuit. Van and remaining crew drive off to a second launching site.

• **T−1 min.**—Goes on internal and boom elevates automatically to firing position. On go.

• **T+2 mins.**—Launcher departs to reloading area.

• **T+2½ mins.**—Air burst over target area. ⁂



COMPACT SYSTEM is scheduled to be operational in 1963, after more tests

Before House group . . .

Marquardt Describes LACE, NULACE

Developer claims high efficiencies for engines aimed at use in Aerospace Plane—hybridization enhances overall performance

FIRST DETAILS of the liquid air cycle engine (LACE) and nuclear liquid air cycle engine (NULACE) under development by Marquardt Corp. for possible Aerospace Plane applications have been released by the House Space Committee.

Testimony on the engines was presented to the committee during its March hearings on space propulsion technology.

Marquardt has been developing critical components and technology for LACE under an Air Force-sponsored program.

The company described LACE as an engine which employs the refrigerating capability of liquid hydrogen to cool and liquefy air from the atmosphere. This liquid air then is pumped into a rocket thrust chamber and burned with the hydrogen used to liquefy it.

"There are many advantages in an engine of this type, as study of its installation in an aircraft in combination with ramjet engines will reveal," the company said. "We can point out here that pumping the air as a liquid results in a reduction in size and weight of propulsion machinery over any other air-handling devices."

The company told the committee in its written testimony that the extension of aircraft operations into space is considered by Marquardt as the most probable way in which routine, reliable and economical operations in space will come about.

It said the earliest of the Aerospace Plane-type vehicles is expected to exhibit almost a two-fold gain in the fraction of weight in orbit over rocket-boosted vehicles of the same time period. LACE was described as several times more efficient than the chemical rocket engine.

NULACE, the nuclear version of LACE, was said to be more efficient than the *Rover* nuclear rocket engine.

"As with *Rover*," Marquardt reported, NULACE will require more development before its availability will equal that of chemical air-breathing engines. Nevertheless, the promise of the nuclear orbital airplane is great. . . ."

• **Happy wedding**—NULACE is a hybridization of the nuclear rocket with LACE. Noting that hybridization of two powerplants frequently results in only physical combining of the engines with no overall performance gain, Marquardt asserted that the NULACE combination results in performance much greater than that of either alone.

"Uniquely, the performances of LACE and nuclear rocket are additive in this hybridization, almost without parallel in propulsion concepts," it said. Specific impulses more than twice those of *Rover* were said to be attainable.

The report noted that an orbital aircraft could take off on initial boost from the ground without operation of the nuclear reactor, thereby eliminating ground radiation hazards.

"Even without the reactor operating, NULACE is capable of higher specific impulses than *Rover*," the company said. After reaching a safe altitude, the vehicle's reactor then would be started to attain the full performance potential of NULACE.

On departure from the atmosphere, the air-breathing portion of the orbital aircraft's NULACE engine would be shut down for operation as a conventional nuclear rocket.

Marquardt said the size of the reactor required for NULACE in an orbital airplane is several times smaller than the reactor required for *Rover* to deliver equal payloads into space.

The report said development of NULACE depends upon development of both LACE and *Rover* but no major technological breakthrough appears necessary.

General Electric and Pratt & Whitney are known to be developing similar engines for Aerospace Plane application, but no details were released. ⁂

Thiokol Wins Contract for 3rd-Stage Dyna-Soar Motor

THE BOEING CO. has awarded a multimillion-dollar subcontract to Thiokol Chemical Corp. Elkton Division for a solid-fueled third-stage accelerator/escape rocket in the Dyna-Soar system.

Described as a "foreshortened Minuteman second stage," the 60,000-lb.-thrust motor will be designed to provide additional thrust for the Dyna-Soar glider or act as the escape propulsion system in the event of a failure during launch (M/R, March 6, p. 12).

The contract—one of the largest yet awarded in the program—calls for design, development, test and manufacture of the motor.

Boeing said it is buying a package from Thiokol consisting of the nozzles, thrust vector control system, igniter system and propellant. The motor probably will not be used on the initial subsonic glider drop tests from aircraft at Edwards AFB, Calif., during pilot familiarization and landing studies. However, it will be fired in later drop tests to check supersonic performance.

While the contract may run to several million, no dollar figure was given. Nor was the number of rocket motors mentioned.

Boeing last week also awarded a major subcontract to Electro-Mechanical Research Inc. for development of the Dyna-Soar test instrumentation subsystem. The amount was not revealed. But industry sources expect the complete data system will cost close to $12 million.

EMR will provide both airborne and ground equipment for collecting and processing test data.

Airborne equipment will include both PCM (pulse-code modulation) and FM (frequency modulated) conversion equipment, a time-coded generator, and a tape recorder for data storage. Ground systems will include equipment for receiving, recording, processing, and displaying.

The communication and data link subsystem—to transmit collected information from the vehicle to the ground—will be developed by RCA, Dyna-Soar associate contractor.

Follow-on a-building . . .

Troy IIA-1 Run Aids Pluto Outlook

by Frank G. McGuire

JACKASS FLATS, NEV.—A successful first power run of the *Tory IIA-1* test reactor has given a boost to the joint Air Force-Atomic Energy Commission Project *Pluto*—the nuclear ramjet engine development program.

The reactor was operated May 14 at approximately 25% of the 150-thermal-megawatt maximum design power for 45 seconds.

The power run was held off two days due to strong winds, despite presence of nine congressmen and a number of top USAF officials. AEC was fearful of uncontrollable fallout patterns due to the winds.

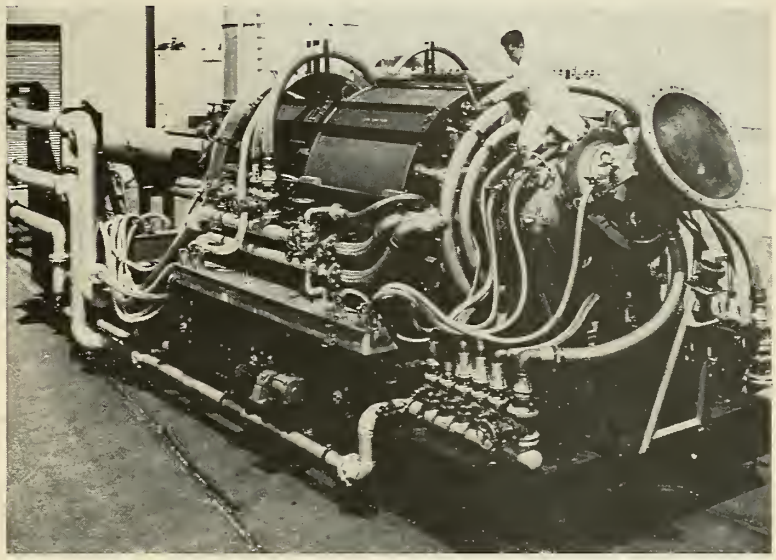
The 40-thermal-megawatt run was intended to demonstrate the engineering feasibility of the core design. Under development by the Livermore Radiation Laboratory of the University of California, *Tory IIA-1* operated at temperatures well in excess of 2000°F. Exact temperatures were classified.

• **Days to hours**—An interesting switch in terminology for the Supersonic Low Altitude Missile *(SLAM)*, which utilizes a nuclear ramjet, was noted. Brig. Gen. Irving Branch, responsible, for the program, stated last December that a *SLAM*-type vehicle could operate "for several days." (M/R, Dec. 19, 1960, p. 16.) The Air Force now says such a vehicle could operate at Mach 3 "for several hours."

AEC officials say the factor limiting flight duration will be the ability to retain the fuel elements within the core. Flight stresses will cause high erosion rates and fuel element ejection from the exhaust nozzle. Materials with long-duration resistance to high heat levels are also expected to be a problem.

The recent test was initially planned for January, but had to be postponed to allow repair of rail car and test bunker couplings which were damaged when the rail car accidentally rolled down an incline into the concrete bunker.

Pluto, now the major project in the Air Force's aircraft nuclear propulsion office, will provide power for the *SLAM*, a program to create a "suspense missile" capable of long-duration aerial patrol similar to that now provided by B-52 bombers. In this application, it may well do the job assigned the ill-fated nuclear-powered aircraft but at lower cost, due to reduction of shielding problems.



TORY IIA EXPERIMENTAL REACTOR appears all but buried in a maze of cooling pipes and air passages. The massive graphite reflectors behind the technician cover the core vessel to block escaping neutrons.

Tory IIA-1 is a direct-cycle, air-cooled reactor using fuel elements of highly-enriched uranium homogeneously mixed with beryllium oxide. Its backup reactor, designated *Tory IIA-2*, is similar in all respects except fuel elements design. *Tory IIA-1* elements number 100,000 and the AEC originally placed its operating temperature at 2300°F.

Test Sequence

First run of the Tory IIA-1 followed this general countdown sequence:

Arm air supply. Start light water pumps. Close reflectors to 6 in. Start heavy water pumps. Verify that reactor is in the "scram" mode. Start control system hydraulic pump. Close reflectors. Begin approach on critical standard start procedure.

Arm automatic control system. Transfer to log power automatic control. Increase nuclear power until pre-planned core temperature is reached. Start strain gage recorders.

Increase power until maximum pre-planned core temperature is reached. Hold for 45 secs. and decrease temperature to former level.

Stop strain gage recorders. Transfer to manual servo. Run in all vanes and control rods. Scram reactor. Withdraw reflectors. Secure heavy water pumps.

The core measures 30 in. in diameter and 45 in. long, with half the cross-section being void to allow air passage. Each fuel element is a hexagonal rod 4 in. long and ¼ in. across the flats. A $\frac{1}{50}$-in. hole is longitudinally located in the center.

The problem of core retention centers around the 100,000 lbs. pressure exerted on the face of the reactor during operation. The support structure must contain this pressure at 2300°F and in a high-radiation field. The core is surrounded by a graphite reflector to aid in the nutronics of the design, since the core itself is not large enough to sustain a chain reaction. The escape of neutrons is hindered by the reflector, sustaining a reaction.

• **New fuel contract**—LRL is concurrently developing a follow-on reactor for the *Pluto* program—the *Tory IIC*, an advanced design of classified configuration. Hardware is currently being fabricated and the fuel elements will be made under a $4.29-million contract awarded to Coors Porcelain Co. by Lawrence Radiation Laboratory. The fuel will be enriched urania-beryllia.

Tory IIC will have a more streamlined configuration. The air supply at the flats will be increased from the current 120,000 lbs. to about 1.2 million lbs. for subsequent reactor tests. ❖



ROBIN NOSE CONE is attached to Arcas booster rocket at Eglin AFB by S/Sgt. Seddon Whatmough Jr. and A/2C Elston Brooks.



SIMPLE PROCESS of loading Arcas-Robin into launcher is demonstrated by S/Sgts. Robert Basins and Charles Herron.

Weather Rockets Fired One-an-Hour



AIMING SKYWARD, Basins and Herron prepare to launch Arcas-Robin. Eglin AFB fired 24 on an hourly basis May 9-10.

Record set by Eglin crews with Arcas-Robin systems used to collect data on upper atmosphere, train weathermen

THE AIR PROVING Ground Center at Eglin AFB, Fla., set a record May 9 and 10 by launching 24 weather sounding rockets in 24 hours.

The rockets were *Arcas-Robins*, designed to obtain meteorological information from the stratosphere in the region between 16 and 45 miles altitude.

The 8-ft. *Arcas*, manufactured by Atlantic Research Corp., carries an 8½-lb. payload, including a balloon that inflates at 225,000 ft. and remains inflated until it falls to about 90,000 ft.

The first of the rockets was launched from the APGC facility at Santa Rosa Island at 6:30 p.m. May 9. One rocket was launched every 60 minutes until the next day.

The program serves a dual purpose. Information is obtained on upper atmosphere weather conditions and U.S. weather personnel are being trained to develop an operational rocketsonde system. The program began last Oct. 11 and will be completed this month.

Later this year, an additional 100 *Arcas-Robin* systems are to be launched from Santa Rosa Island with modified payloads.

Eventually, the U.S. weather services hope to establish a network of rocket-launching sites across the country to obtain coordinated data on stratosphere conditions on a regular basis. In addition to existing launch sites operated by the military services and the National Aeronautics and Space Administration, there are proposals to set up one or more facilities in the midcontinent area.

The greatest need for the high-altitude weather data has developed with high-altitude jet transport flight. ⁂



ROBIN BALLOON, which inflates at altitude after launching by Arcas, is examined by scientists at Air Proving Ground.

Business in Billions Is Forecast

WORLDWIDE communications by satellite is expected to be one of the earliest and most profitable commercial uses of space. But there are many problems still to be solved. George J. Feldman—former director and chief counsel of the Select House Space Committee, a principal author of the National Space Act and a well-known New York corporation lawyer—has studied these problems for many years. At this time when communications satellites are more than ever a subject of national and international interest, Feldman has written a comprehensive survey of the subject for MISSILES AND ROCKETS. *—Ed.*

by George J. Feldman

THE COMMUNICATIONS satellite promises to be the earliest big money payoff from space exploration.

Within the next few years, communication by satellite could easily become a multibillion-dollar business. Within 10 to 15 years, the communication satellite business could well become a $100-billion-a-year business.

Moreover, communication satellites promise to be the first form of space technology to enter our daily lives and revolutionize our ways of doing business.

Thus it is important to see just what communication satellites can do for us and to look at the many associated problems that we are going to have to face.

To begin with, why do we need communication satellites?

• **Capacity**—They would permit the long-range transmission of higher frequencies (traveling in straight lines), and therefore could provide a great number of additional channels for long-range telephone, telegraph, radio and television service. Microwave channels already in use are badly congested, and the demand is rising rapidly. In 1960, for example, some 3 million overseas telephone calls were made or received in the United States. The number is expected to reach 21 million by 1970, and 100 million by 1980.

The rapid growth of technology and population all over the world is threatening the continued use of frequencies that Western countries have had to themselves. Also, the exploration of outer space will increasingly demand reliable communications between space vehicles and ground stations. Some of the very early practical applications of space technology—notably for weather forecasting, navigation and surveillance—will also utilize wide bands of radio frequencies for communications.

Satellites offer the only known way to meet this expected increase in demand. A system of two earth-synchronous satellites could provide some 2,000 more telephone channels, compared to only 100 or so for an underwater cable.

• **Reliability**—According to current estimates, satellite communication systems will prove to be more reliable than either cable or radio links. For example, they will not be subject to interference by sunspot activity or the cutting of underwater cables.

• **Costs**—Will communication satellites give the first answer to the question, "How can you make a buck in space?" They probably will. It is still hard to estimate the costs, partly because they depend so much on the useful life of the satellite components. The minimum economical life of a communication satellite is about one year. Most cost estimates assume an expected life of about five years.

According to some estimates, an active low-orbit system would cost about $150 million initially and $10 million a year to operate. A system with 3 stationary (24-hour) satellites might cost twice as much. At present rates, gross revenues from a 1000-channel telephone system would amount to nearly $100 million a year. From estimates like these, it appears that satellite communications will be profitable at least by 1970. Initial costs could probably be paid off within a decade.

Consumers will benefit, too. It is believed that the cost of satellite communications per voice-channel mile will eventually be lower than that of present long-range communications systems.

Satellites are expected to be useful in military as well as civilian communications, mainly for reasons of capacity, reliability and security. In remote or undeveloped regions, furthermore, satellite relays can be set up quickly, while conventional long-range communication systems may take years to complete.

• **Thorns in the path**—What policy problems will satellite communications create? At this stage of history we can give only a partial list.

• **Frequency allocation and use**—Almost everyone agrees that early international allocation and domestic assignment of channels are needed for earth-space service and for radio astronomy. An international agreement will obviously be required, but may be difficult to negotiate.

International microwave communications will also raise the problem of equipment compatibility, particularly for television broadcasts.

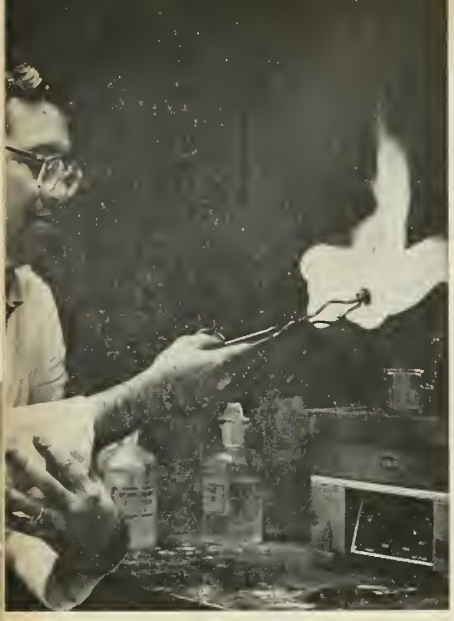
• **Sharing of benefits and costs**—Another problem will be the sharing of benefits and costs (a) among governments and (b) between governments and private users. For example, who will pay for what and how much? If the Government launches commercial satellites at cost, as NASA has already offered to do, then the taxpayers in general, and not just the users of the satellite service, will be footing the bill.

• **Control of program content**—Controlling the content of radio and television programs transmitted by satellite will create new problems of licensing and regulation. No television system now available can send programs farther than 100 miles or so. Television programs relayed by satellite, however, could be sent from one continent to another. It is easy to foresee that this could become a hot international issue. Just imagine U.S. propaganda programs that could be received by private citizens in Communist countries.

• **Roles and relations of government and private industry**—The American people enjoy a long tradition of leaving telecommunications to private enterprise. Our Constitution guarantees freedom of speech and the press. Yet government support seems inevitable, if only because the necessary technology involves high costs and heavy rocketry. Regulations, in any event, would be essential.

Apart from the central problem of the relationship between government and private enterprise, we will also have to decide what agency within the government will make the policies, lay down the rules, grant licenses, adjudicate controversies and enforce the rules and decisions. Here is an area full of pitfalls and controversies. On what grounds will the responsible agency decide to license one private company rather than another? What agency will be primarily responsible: NASA? FCC?

(Continued on page 39)

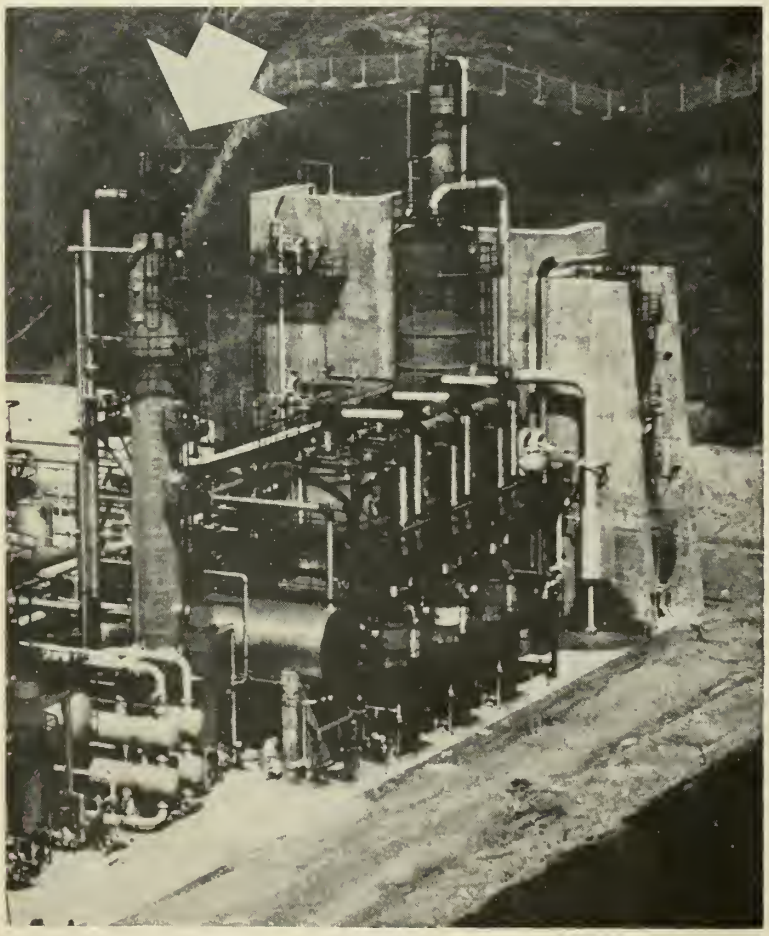


ANHYDROUS HYDRAZINE in copper mesh bursts into flame when waved in air.

World's biggest . . .

Olin's Anhydrous Hydrazine Plant Producing

Heavily automated facility in Virginia mountains makes fuel for Titan II missile and Dyna-Soar program



AMMONIA CONDENSER section of the plant in Southwest Virginia's Alleghenies.

THE WORLD'S largest anhydrous hydrazine plant went on stream last week at Saltville, Va., with the Air Force as its sole customer.

The anhydrous hydrazine will be used in the *Titan II* missile and in the *Dyna-Soar* program. Built and operated for the Air Force by the Chemicals Division of Olin, the $15-million plant will operate on a round-the-clock schedule.

Precise capacity and certain process details are classified, but the entire three-year contract totals $25 million.

Olin perfected techniques for producing hydrazine shortly after World War II. The first part of the Olin process is the basic Rashig synthesis which leads to the formation of hydrazine hydrate. The next section, dehydration of the azo compound, is regarded by Olin as proprietary.

Basically, hydrazine is the result of three separate reactions. Sodium hydroxide is mixed with chlorine to produce sodium hypochlorite, salt and water. The hypochlorite is then reacted with ammonia to make chloramine and sodium hydroxide. Ammonia is reacted with these two products, forming hydrazine, salt and water.

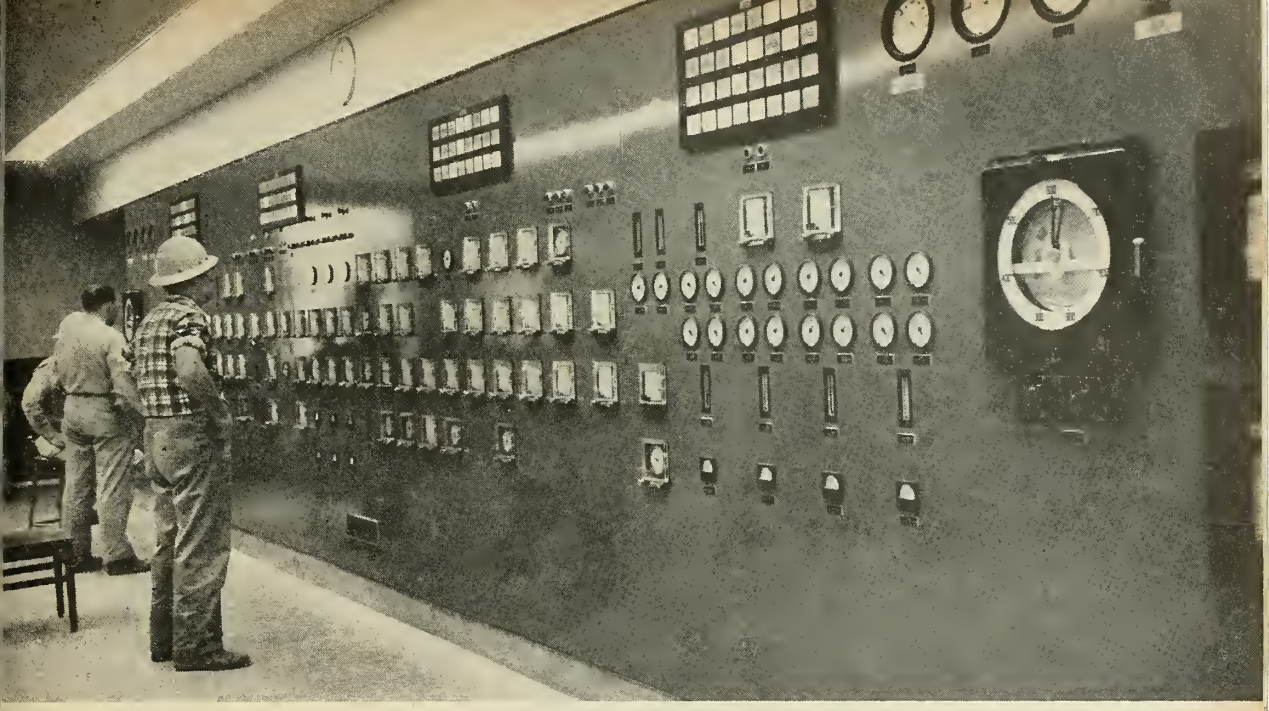
The plant is highly automated. Four men operate the entire process on a shift. Four other men take care of the loading/unloading, utilities and water processing.

The three shifts with support personnel total about 100 persons.

The plant also has a water pollution control unit that both safeguards local streams and recovers certain chemicals for re-use in the process.

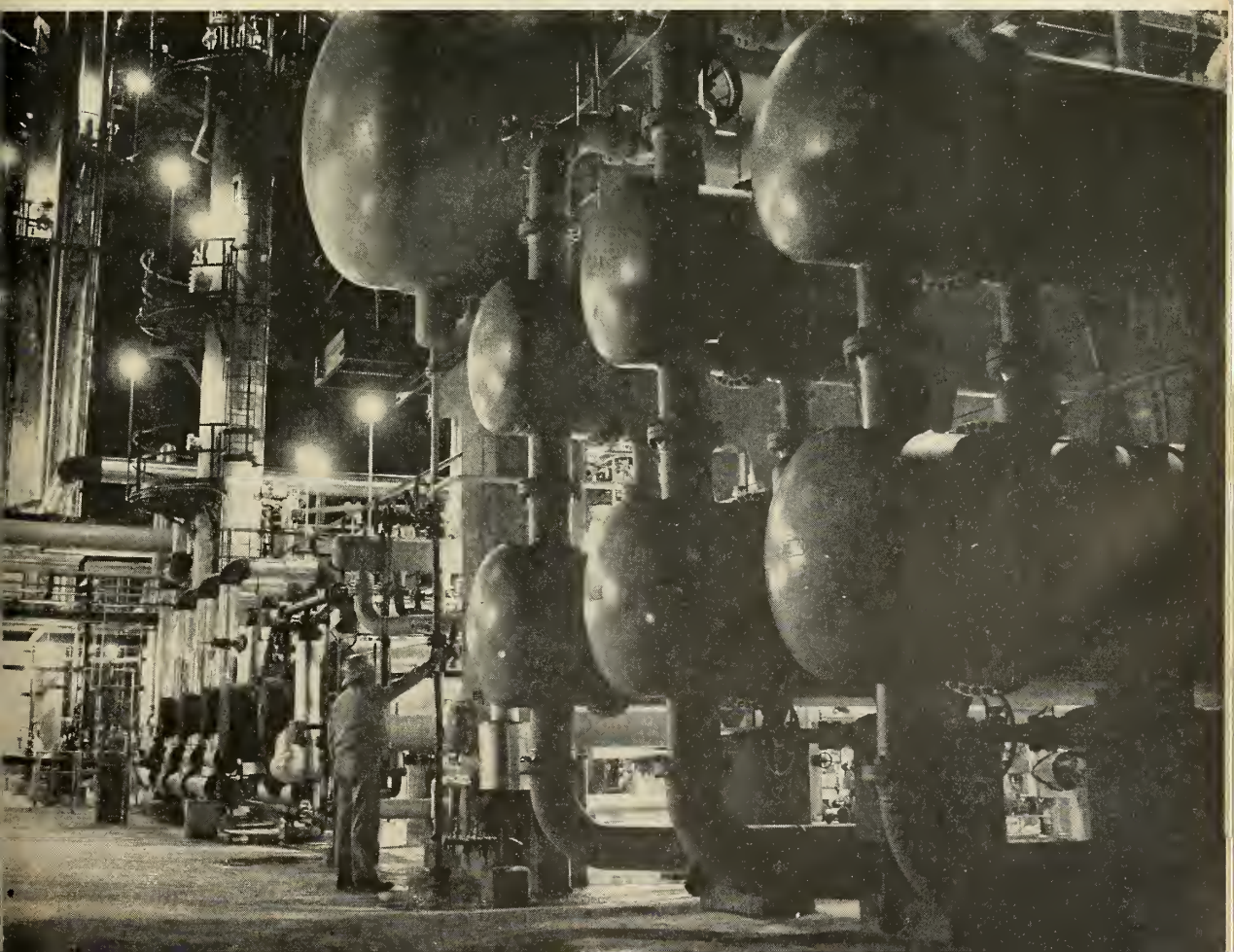
The hydrazine will be mixed with unsymmetrical dimethyl hydrazine in the *Titan II* missile. The mixture can be used with storable oxidizers such as nitrogen tetroxide for propulsion purposes. The two are hypergolic.

Olin broke ground for the plant in June, 1960. Arthur G. McKee & Co., a Cleveland, Ohio, construction firm, finished the job in nine months under the direction of Olin engineers. ⌘



ABOVE: *The nerve center of the highly automated plant. Four men oversee the entire process.*

BELOW: *The distillation tower is an integral part of the proprietary Olin anhydrous hydrazine method.*



TITAN—newest triumph of **S**pace **T**echnology **L**eadership



The nation's first in-silo launch of an ICBM marks a major milestone in the timely development of USAF Titan—and a signal success for an industrial team led by scientists and engineers of Space Technology Laboratories, Inc., under Air Force program management. This successful test confirmed the STL design solution to the unparalleled vibration problems created by the roar of Titan's 300,000-pound thrust booster engine within the confines of its 10-story underground silo. ■ Two years ago, studies by STL as contractor to the Air Force for systems engineering and technical direction of the Titan program, indicated that in-silo launching which provided invulnerability and enormous economy was technically attainable. But one major problem had yet to be solved: proper control of the noise-created vibration during the first few seconds of in-silo firing which, if uncontrolled, would literally shake apart the 97-foot Titan. Research and analysis by STL produced the solution, verified by the dramatically successful test at Vandenberg Air Force Base on May 3, 1961. ■ The successful launch of Titan I demonstrated the soundness of STL silo design concepts for the Air Force Titan II program. Titan II is a fast reacting, highly flexible weapon of maximum range and destructive capability—a new and potent element in deterring aggressor attack. ■ Today STL scientists and engineers are actively engaged in the program that is producing soon-to-be-operational Titan I and quick-reacting Titan II. Their responsibilities in this, as well as in the Atlas and Minuteman programs, create career opportunities for additional numbers of outstanding scientists and engineers. For opportunities with STL in Southern California or at Cape Canaveral, please write to Dr. R. C. Potter, Manager of Professional Placement and Development, at either location.

TITAN TEAM. Program Management: Ballistic Systems Division, Air Force Systems Command. **Major Associate Contractors:** Space Technology Laboratories, Inc., systems engineering and technical direction; The Martin Co., airframe, assembly, and test; Bell Telephone Laboratories and Remington-Rand UNIVAC, radio guidance; AC Spark Plug, all-inertial guidance; Aerojet General, propulsion; Avco Corp. and General Electric, re-entry vehicles; American Machine & Foundry, silo-lift launcher system; A. D. Little, propellant loading system; Daniel, Mann, Johnson, Mendenhall & Assoc. and Ralph M. Parsons Co., architects and engineers; Kellogg Switchboard & Supply Co. and Stromberg-Carlson, communications.

SPACE TECHNOLOGY LABORATORIES, INC. P.O. BOX 95005F, LOS ANGELES 45, CALIFORNIA

a subsidiary of Thompson Ramo Wooldridge Inc.

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All qualified applicants considered regardless of race, creed, color, or national origin.

Technical Countdown

ELECTRONICS

English Build Better Gyro Test Gear

English Electric, developer of Britain's *Thunderbird* and *Blue Water* missiles, uses U.S.-designed gyros—built under Northrop and Honeywell licenses—but has had to develop its own test equipment. Some of the resulting items, they say, are better than any comparable equipment in the free world.

DAC to Aid Nuclear-Age Defense

DOD Damage Assessment Center—scheduled for operational status in July—will include computers and automated display systems to provide instantaneous assessments of damage sustained in nuclear attack. In peacetime, the DAC will be used to provide up-to-the-minute assessments of U.S. and allied military forces and economic resources vs. enemy potential.

ENERGY CONVERSION

Higher Efficiencies

Efficiency of 15-17% has reportedly been obtained with a new vapor thermionic converter developed by General Electric. Power output of 23 watts was obtained at 1530°C. GE says the cesium-vapor converter is a "practical" device and can be reliably produced in quantity for space and military applications.

Municipal MHD Powerplants in the USSR

Plans have been completed by the Russians for MHD powerplants with capacities up to 450,000 kw. Coal, oil, gas and nuclear fuel are mentioned as possible energy sources. Combustion chamber temperatures will reach approximately 5250°F. Efficiency would be 60%. Present knowledge of gases at high temperatures and heat-resistant materials is said to assure attainability of such plants.

ADVANCED MATERIALS

400-lb. Zinc Crystals

A program under way at Semi-Elements, Inc., will increase the size of single crystals of zinc to 400 lbs. The biggest to date is 30 lbs. As is, the price for 5 x 5 in. ingot is $100 per lb.

Hydrogen Embrittlement of Tantalum Prevented

Attachment of an extremely small relative amount of platinum metal to tantalum inhibits hydrogen embrittlement. Scientists at Union Carbide Metals Co. have immersed tantalum samples in HCl at 374°F for more than 1000 hours without embrittlement. The platinum is affixed by sputtering, spot-welding or mechanical attachment. It is not alloyed to the tantalum.

Turbine Diaphragms Investment-Cast

A method for one-piece investment casting of small gas-turbine engine diaphragms has been developed by Austenal Co. The hollow diaphragms are lower in cost, weigh less, and last longer than conventional parts. A wider design latitude and choice of alloys is also possible.

Gas-Lubricated Bearing Operates at 1500°F

Tribo-Netics Laboratories ran a single gas bearing through a temperature range from 75° to 1500°F at speeds up to 65,000 rpm. Under an Air Force contract, the firm is building an all-ceramic rig to raise the operating temperature to 2200°F. Nitrogen, helium, argon and CCl_4 gases will be investigated.

Paging the Fuller Brush Man

Wire brushes will be the main landing gear skids for the *Dyna-Soar*. Since brakes and wheels have been ruled out, the friction generated by the brushes on landing is expected to bring the craft to a halt. Goodyear Tire and Rubber Co. will develop the concept under a $45,000 contract from Boeing Co.

SUPPORT EQUIPMENT

Navy to Get Long-Range Radar

Future Navy missile cruisers and carriers will be equipped with the longest-range height-finding radars yet developed. The AN/SPS-30—proved out in evaluation tests last summer—will be built by General Electric under a $35-million contract. First model is scheduled for delivery in May, 1962.

ASTRONAUTICS

Happy IQSY

Follow-on to the International Geophysical Year will be the IQSY (International Year of the Quiet Sun). Sun spots will be at a minimum during an 18-month period in 1964-65, and scientists all over the world will cooperate then in studying effects of the quiet sun on earth's atmosphere. Some experts predict a crisis in normal radio communications, which depend on an atmosphere strongly ionized by sun activity.

Radiation Shielding in Space Unnecessary?

Martin Co. geophysicists say that heavy shielding will not be necessary to protect space travelers from radiation. Apart from minor spot-shielding, they predict, the vehicle's shell and its equipment will provide adequate protection. The conclusion resulted from work on a feasibility study of the moon-orbiting *Apollo* spacecraft.

ASW ENGINEERING

Bat Radar-Sonar Techniques Studied

The Navy is studying bats that catch fish in an effort to develop advanced navigation, communication, and detection systems. Researchers feel that more knowledge of *Noctilio* bats' radar-sonar mechanism, used to locate fish underwater, may yield some interesting techniques that could improve on man-made detection and locating equipment.

An M/R Exclusive . . .

First Details of Pershing GSE

by Hal Gettings

ALL ELEMENTS of Pershing firing section are carried by XM-474 tracked vehicles. Lead vehicle (left foreground) carries warhead, spares and tool chest.



COMMUNICATIONS TERMINAL can be put into service by two men in 10 minutes or less after arrival at firing site.

THE ARMY'S unique approach of developing ground support equipment concurrently with the missile it serves has paid off handsomely in the *Pershing* program. The net result, Army missilemen say, will be a complete field-firing section ready to go the day the missile is declared operational.

The lightweight, highly mobile, quick-reacting system is designed for transportability and fast-and-easy interconnection. On arrival at a firing site, its modular units can be tied together, and the missile erected and ready for launch, in less than 10 minutes.

Reliability has been heavily stressed in the missile development—to minimize maintenance, reduce logistic support requirements, and simplify operation with a minimum crew.

The Army has just revealed the components of the complete firing section. This self-sufficient mobile tactical base—transported by helicopter or brought overland under its own power—is composed of four units, each on an identical tracked vehicle.

The missile is carried in its transporter-erector-launcher (TEL) atop one of the XM-474 tracked vehicles. Another vehicle carries the warhead, spares and tool chest. Fire-control, test, and checkout equipment and the primary power supply are carried on a third. The fourth contains the complete communications terminal.

• **TEL**—Principal item of support equipment of the *Pershing* firing section is the TEL. This unique wheeled vehicle carries, erects, and serves as a launching platform for the missile. It rides on an XM-474 or can be towed on its own wheels; it can launch the missile in either position.

An umbilical mast is an integral part of the system.

Power for operation is supplied by two motors. An 11-hp motor raises the missile to within five degrees of vertical. A 3-hp motor stabilizes the erector at 90 degrees from the horizontal. Erector boom, with missile, can be raised or lowered in one minute. Stabilizer jacks and azimuth ring are integral components of launch platform.

Three integral stabilizer jacks are lowered to provide the stable base for firing. The two forward jacks are lowered electrically and the rear jack manually. Base plates are installed on the stabilizer jacks to give added stability and flotation.

After the stabilizer jacks are lowered to the base plates, the launcher is then automatically leveled. An electrical interlock prevents missile erection until leveling is accomplished.

During erection, the missile is physically supported at its base by a peripheral clamp, and at the forward end by a clamping device attached to the boom.

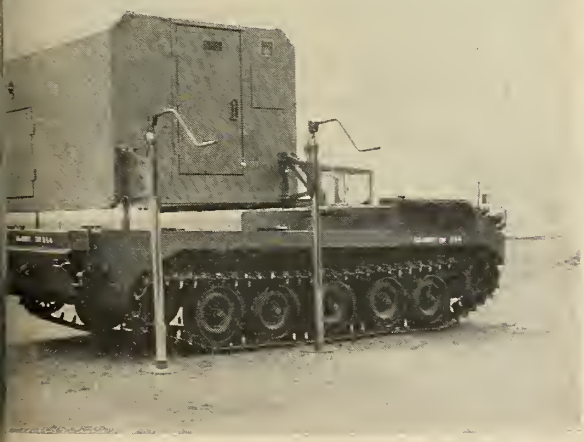
The missile is raised to within five degrees of the vertical by the erector boom. The remaining five degrees of erection is accomplished by a smaller motor, automatically initiated, which lowers *Pershing* slowly to the launcher. This fine control, with the smaller motor, is necessary to prevent missile

Germans Order Pershings

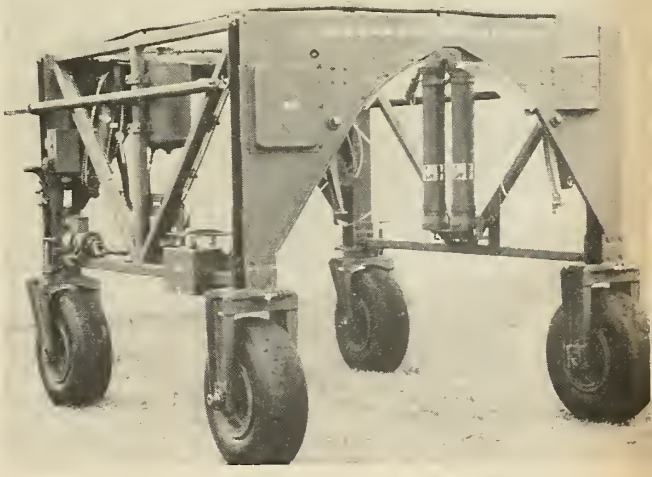
WEST GERMANY has placed an order for Martin Pershings valued at approximately $120 million.

Sources in Germany indicate that the amount is almost identical to that which the West Germans had earmarked for the purchase of Martin Maces. The Mace order was cancelled earlier this year.

Unit prices of Pershing missiles have not been disclosed. But it is believed the Germans will obtain approximately 60 under their initial order. The 350-mile tactical missile is expected to be operational late this year.



COMMUNICATIONS HUT can be mounted on XM-474, carried by helicopter, or towed (on "mobilizer" wheels) by light truck. It is lifted by jacks to allow vehicles to back underneath.



DOLLIES EQUIPPED with built-in hydraulic lifts are used to pick up and carry Pershing sections for air transport and re-supply handling.



CHINOOK YHC-1B HELICOPTERS can carry entire Pershing firing section, giving the Army's new tactical missile system its high degree of mobility.

XM-474 Tracked Vehicle

Length (overall):	18 ft.
Width (overall):	8 ft. 4 in.
Reducible height:	5 ft.
Ground clearance:	16 in.
Performance:	
Speed forward	40 mph
Cruising range:	200 miles (approx.)
Max. grade (ascending, descending):	60% slope
Max. side slope:	30% slope
Curb weight (with fuel):	11,900 lbs. (approx.)
Payload capacity:	12,100 lbs. (normal) 16,300 lbs. (overload)

Power train and suspension components are identical with those in standardized M-113 personnel carrier.

XM-474 can ford 42 inches of water and, with adaptian kit, can be made amphibiaus. Vehicle weight is corried by 10 dual road wheels rolling on tracks. Wheels are mounted, five on each side, on road wheel arms, splined to torsion bars. Vehicle is capable af operating, under full load conditions, in climate ranging from —65°F to +125°F.

Pershing's Vital Statistics

Length:	34 feet
Diameter:	40 inches
Propulsion:	Two-stage, solid-propellant rocket motors
Guidance:	Inertial
Warhead:	Nuclear
Range:	Classified (Exceeds *Redstone* range of 200 miles)
Weight:	Classified
Payload:	Classified
Contractors:	Martin-Orlando, prime; Thiokol Chemical, rocket motors; Tapco Group of TRW, TEL; Collins Radio, communicotions; Bendix, guidonce; Bulova Reseorch, fuzing and arming ond adaption kits; Ford Instrument, fuzing and arming (parallel development)

YHC-1B Chinook Helicopter

Dimensions: Corgo compartment, 6' 6" high; 8' 3" wide; 30' 2" long. Rear entry access, 7' 6" wide. Loading ramp, 6 degrees, 40 minutes slope.

Payload: Normal mission poyload for 100 n.m. rodius, over three tons. Alternate mission payload for 100 n.m. rodius, six and one-holf tons.

Cruise speed: Average 125 knots ot 5000 ft.

Service ceiling (one engine out): 7000 ft.

oscillation when it reaches the vertical position.

When the missile is in the vertical position, the boom is returned to the travel position. The missile can then be automatically rotated to the firing azimuth.

• **Communications terminal**—Complete battlefield communications facilities for the firing section are contained in one pack which provides both radio and teletype equipment for local and higher echelon contact. This portable communication terminal—the AN/TRC-80—can be on the air in 10 minutes after arrival at a site. Using tropospheric scatter, operation of the terminal is unaffected by ionospheric conditions or conventional ionospheric jamming techniques. The system provides 777 operating channels without crystal changing.

• **Power pack**—Primary power for the firing section of the *Pershing* battalion is provided by a compact, portable unit mounted on an XM-474. A gas turbine engine powers an ac-dc generator which supplies electric power to operate the TEL, fire-control equipment, and the missile. The turbine engine also supplies compressed air to separate the umbilical mast from the missile and to other areas as required.

Pershing is the first ballistic missile development program conducted by a prime contractor for the Army. It also is the first which called for concurrent development of the ground support equipment with the missile. The success of this approach has been borne out by the fact that all test firings have been made from the TEL. Other support components have come along on the same schedule to reach a common operational date.

The entire *Pershing* development program has met with unusual success. Prime contract was awarded Martin-Orlando in March, 1958. One year later the first missile was delivered to ABMA for static test and captive firing. The first flight test came in February, 1960—less than two years after contract award.

The sixth launching was made from the TEL, mounted for the first time on its tracked-vehicle carrier. This, too, proved successful.

An essentially operational version of the *Pershing*—with improved motors, new configuration, and internal design improvements—was successfully fired on April 21, 1961.

In all, a total of 15 missiles have been fired in the R&D series, Thirteen of these were unqualified successes, one a "partial" success, and only one a total failure. From this, Army missilemen are confident that the missile will become operational on schedule late this year. ⁂

U.S. Urged to Exploit Nuclear Lead

by John F. Judge

GATLINBURG, TENN.—U.S. space programs should be directed towards the planets—with lunar missions a preliminary or interim operation using the technology developed for planetary shots.

H. B. Finger, Manager of the Joint Atomic Energy Commission-National Aeronautics and Space Administration Space Nuclear Propulsion Office, said that such a long-term program would depend heavily on nuclear rockets—a field in which the Russians are a sorry second.

Finger told a Space Nuclear meeting that three research reactors have been tested with gaseous hydrogen as a propellant and water as the pressure shell and nozzle coolant. The *Kiwi-A* series was successful and the *Kiwi-B* series of reactor tests, to be initiated later this year, will include some runs with liquid hydrogen as a propellant and as a coolant for all critical parts.

The *Kiwi-B* series should lead to development of reactors for the first flight tests of the nuclear rocket system.

Finger cautioned that success in the nuclear rocket program is not yet assured, but he said the work to date is very encouraging.

The meeting was sponsored jointly by the American Rocket Society and the Oak Ridge National Laboratory, operated for the AEC by Union Carbide Corp.

A special session was devoted to the *Saturn* booster system. Dr. Wernher von Braun described the *Saturn* in detail and covered the *Apollo* concept. The rocket expert said that a set of fins would be added to the big booster for better control under adverse wind conditions.

Von Braun's description of the *Apollo* vehicle did not include any glide capability. The *Apollo* would re-enter in a manner similary to the *Mercury* capsule.

Space rendezvous, escape procedures and power module configurations were also mentioned in connection with *Apollo*.

Von Braun said nuclear rockets would probably be limited to orbit operation and beyond—no ground launchings. He also sounded a wary note by categorizing nuclear propulsion as a "day-after-tomorrow" event. But in any case, he said, the work must be started today.

Flight Test Schedule

CY	1962	1963	1964	1965
Arc Jet Engines	1	3	2	1
Ion Engines	3	10	7	2
MFM Engines	—	1	3	3
SCOUTS	2	7	6	3
Arc Jet Engines		1	1	—
Ion Engines		1	2	1
MFM Engines		—	1	1
AGENAS OR CENTAURS		1	2	1
Arc Jet Engines				1
Ion Engines				1
MFM Engines				—
CENTAURS				1

TENTATIVE NASA flight plans.

• **Big science**—The triple "diseases" of large-scale science—journalitis, moneyitis and administratitis—were covered in detail by Dr. A. M. Weinberg, Director, ORNL.

The nuclear expert expressed fears that big science is ruining the universities by turning qualified professors into publicists, administrators and spenders of big money—at the expense of their professorial duties.

Observing that big science is, with all its faults, here to stay, Weinberg offered a number of suggestions based on his experience with a national laboratory.

He proposed that technical universities be created close to, or in conjunction with the large government laboratories. The main advantage would be the fact that the national laboratories have already made their peace with big science—the onerous housekeeping function, the inevitable layer of administrators and publicists are already in being.

AEC security took its usual toll of papers at the meeting, and in many cases the non-classified presentations had to be restricted to generalities. But rocketmen were given a fairly complete picture of the problems and areas of emphasis in nuclear applications to propulsion and power.

The nuclear experts in turn were were given an insight into electrical propulsion and its demands on nuclear technology.

• **Kilowatt propulsion**—NASA's electric propulsion development program, including tentative flight plans, was discussed by Ernst Stuhlinger, Director, Research Projects Div., Marshall Space Flight Center.

The NASA expert outlined the five-phase development program each of the three systems of propulsion will undergo. Arc jet, ion and magneto-fluid-mechanic (MFM) engines will all flow through component research and development, laboratory model, flight testing and mission phases.

The arc jet is farthest along the road. A 1-kw flight model slated for a short-time flight test in late 1961 is being designed by Plasmadyne Corp. If successful, this model may result in an early application of arc-heated systems for position and attitude control of satellites.

Larger engines for a power output of 30 kw are under development at GE and Avco. These may lead to a flight model, to be flight-tested together with a *SNAP-8* power supply on a 1965 satellite.

Short-flight ion engines are being developed by NASA at the Lewis Research Center, Hughes Aircraft and Electro-Optical Systems.

Stuhlinger said that 15 to 20 *Scouts*, carrying 20 to 25 ion engine models and some arc jet and MFM engines, will be launched between 1962 and 1965. The *Scout* vehicle will provide a total test time of 1-2 hours during a steep parabolic flight.

Two engine models will be carried on each *Scout*, mounted on outrigger arms so that their thrust will increase or decrease the spin of the payload capsule.

To cut costs and increase reliability, the engine-bearing capsules, power supplies, programer, telemeter and command receiver will be of standard design.

J. W. Stearns of Jet Propulsion Laboratory analyzed the various space missions involving electric propulsion. Classes included a planetary flyby, a planetary capture and a planetary orbiter. In each case, the electrical propulsion system is assumed to be in a 300-mile earth orbit.

Missions studied and discussed by Stearns were Mars and Venus orbital shots, Jupiter spacecraft and an out-of-the-elliptic probe.

• **Plasma core reactors**—Advanced concepts for high-acceleration propulsion systems are few in comparison to the innumerable low-acceleration sys-

Limitations Upon Principal System Variables

	Lower Limit	Upper Limit
Size	1. Criticality	1. Wt. of moderotor-reflector 2. Excessive fuel inventory 3. Excessive mag. field volume 4. Fabrication difficulties
Temperature	1. Fuel ionization temp.	1. Radiative heat transfer to walls 2. Propellant ionization
Magnetic Field Strength	1. Plasma confinement 2. Cost of max. tolerable fuel loss by diffusion	1. Electric power requirements 2. Coil weight
Electric Field Strength (Homopolar Configuration)	1. Plasma rotates too slowly a. Therefore unstable b. Therefore axial diffusion intolerable	1. Supersonic flow problems 2. Excessive voltage drop across plasma
Propellant Flow Rate	1. Flow channel cross section excessive (Therefore moderator too heavy)	1. Excessive pressure 2. Helmholtz waves (Therefore propellant swept through nozzle)
Plasma Rotational Velocity (Homopolar Configuration)	1. Plasma instability (Therefore max. permissible propellant flow rate too slow) 2. Approaches diffusion properties of simple magnetic bottle	1. Shock waves and boundary layer turbulence 2. Rotational kinetic energy wasted in spinning propellant

SOME OF THE PROBLEMS involved in developing plasma-core reactors.

tems being investigated. S. T. Nelson of the Aerospace Corp. says this is understandable when it is realized that, for all high-acceleration systems, the specific impulse is proportional to the square root of the engine operating temperature (T) divided by the exhaust gas molecular weight (M).

If the exhaust material is dissociated hydrogen, M would be essentially minimized. Performance would have to be improved by raising the temeperature. Nelson pointed out that the maximum steady-state temperatures withstood by the most refractory structural materials correspond to I_{sp} values in the neighborhood of 1000 sec.

Two approaches have been proposed to overcome this limitation—Project *Orion*, which limits the interaction in time by short-duration pulses, and the plasma-core reactor, which limits the interaction in space by eliminating all solid structure from the immediate vicinity of the hot gas and replacing the confining walls with electromagnetic fields.

Nelson, in one of the longest papers delivered at the meeting, described the plasma-core reactor in a propulsion system capable of imparting a vehicle acceleration greater than 1 g.

In its simplets form, the plasma-core reactor consists of a plasma of fissionable material, confined within a cylindrical or ellipsoidal zone about the axis of a cylindrical chamber by means of a longitudinal magnetic field. This field is generated by electrically conducting coils, bearing strong currents, which surround the chamber.

The field is uniform except for the ends of the cylinder, where it is more intense due to a higher concentration of coils. The resultant arrangement of parallel lines of force bunched in at the ends is referred to as a magnetic bottle; each end is called a magnetic mirror.

• **Nuclear hot dog**—Surrounding the glob of fissionable material in the simplest device is a layer of hydrogen propellant, forming an annulus coaxial with the plasma but inside the solid, porous, chamber wall. The hydrogen flows axially down the chamber, absorbing enthalpy from the plasma core. It is finally exhausted through a suitable nozzle after being heated to dissociation but not ionization.

Nelson says the reason hydrogen is not ionized is that it must be expelled while the expensive fissionable material is retained. The plasma-core reactor relies on magnetic confinement of an ionized fissionable gas which "sees" the confining field barrier and upon the escape of non-ionized hydrogen which does not.

From a strictly nuclear point of view, says Nelson, it is feasible to construct a critical plasma core of reasonable dimensions and fuel inventory. But it is found that the core must be greatly enlarged beyond its theoretical minimum size for non-nuclear reasons.

In addition to enlarging core dimensions to minimize plasma diffusion processes, it is also necessary to maximize the optical depth of the hydrogen layer. Since the initial constraint upon the system variables requires a high-acceleration vehicle, thrust levels upwards of 10^7 lb. are implied. This means propellant flow rates at least of the order of several tons per second.

To pump hydrogen longitudinally across the core at such rates without resorting to excessive axial velocities, the cross-sectional area of the hydrogen annulus coaxial with the plasma must be rather large.

Nelson covered many of the problems relating to the plasma-core reactor. One of the most formidable—plasma instability—was not treated, but the Aerospace Corp. expert suggested some future work in the area. Perhaps the greatest source of instability in the simple magnetic bottle will prove to be Helmholtz waves generated at the plasma-propellant interface.

Other instabilities such as those of the flute, kink and sausage types must also be investigated, says Nelson. Furthermore, it is necessary to develop an analysis of the assorted types of oscillations to which plasma cores of several configurations would be susceptible, and methods of damping.

One last problem area Nelson describes as the most crucial. The central question is: Given a hot, ionized gas—which is itself a heat source—and given a region of non-ionized gas whose function is to absorb radiant energy, and which is situated between the hot source and a physical wall enclosing the entire cavity, what is the temperature profile throughout the absorber as a function of its thickness?

This problem is compounded by our ignorance of the absorptivities and emissivities of hydrogen, and particularly of uranium, at the temperatures and pressures of interest.

• **Doped hydrogen**—Another complicating factor is the radial distribution function for plasma particles in configuration space. In practice, fuel ions will be distributed in the steady state throughout the hydrogen, falling off from maximum density at the interface to some minimum value at the wall.

These fuel ions, while an economic loss, also constitute a doping of the relatively transparent hydrogen by particles more opaque to the incident radiation. This relieves the wall-cooling problem enormously.

Nelson says there is a possibility of further doping the hydrogen with a good radiation absorber having suitable nuclear properties. All of this introduces the hope of maintaining the wall temperature within manageable bounds—but vastly complicates the heat-transfer analysis. ⌘

Exhaustive Tests Bring Reliability

THE XM-55 engine for the first stage of *Minuteman* is a veteran of 61,515 major component tests.

The figure is likely to increase by a factor of two or more by the time the qualification test program is completed.

Dr. Harold W. Ritchey, vice president of Thiokol Chemical Corp., says the tests illustrate the means necessary to attain acceptable reliability in a sophisticated solid-propulsion system closely approaching the boundaries of design knowledge.

• **Balancing act**—Ritchey says an intelligent program design based on an extensive testing program can obtain more reliability per dollar. But reliability must also be balanced with entire program cost, schedule and performance.

The solid-rocket expert compared the testing programs of the XM-20 solid engine used in the *X-17* re-entry test vehicle, the XM-55 *Minuteman* engine, the *Atlas* LR-89 engine and the *X-15's* XLR-99 man-rated engine.

The XM-20 attained a high degree of reliability rapidly and at a relatively low cost because the state of the art was not close to design knowledge boundary.

The *Atlas* LR-89 reflects the larger number of critical components required in a liquid engine as compared to a solid. But reliability is attainable by the experience gained during an extensive test program.

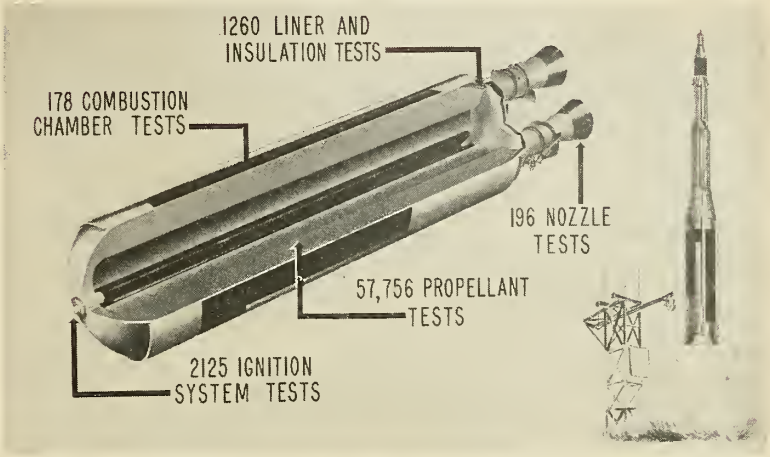
Ritchey emphasized that the complexity associated with more components does not necessarily cause lower reliability—it merely generates a need for extensive test experience.

The statistical reliability represents the combined test experience for both the MA-2 and MA-3 designs. Modifications incorporated into the MA-3 through design and reduction of components have substantially improved reliability compared to MA-2 design.

Based on 28 failure-free tests, a current statistical reliability of 92.8% has been achieved in the LR-89.

A field reliability of 97% has been attained with the XLR-99 even though it has more components than the LR-89. The higher reliability figure was generated by the man-rated safety requirements.

Ritchey pointed out that the final result of reliability attained through comprehensive testing is dependent to a considerable extent on the ability of manufacturing personnel.



NON-DESTRUCTIVE TESTS in first-stage Minuteman engine numbered 144 hydrostatic checks in combustion chamber series. All other tests were destructive.

• **Program aim**—The entire development effort in a propulsion system might be regarded as a program of design and testing to achieve the required reliability. Thus the flight testing would be only 10% of the costs, with engine static tests taking 55%, component tests 30% and initial design 5%.

Within this there is an additional effort devoted to an analysis of the test results. This means highly trained people and complex computing machinery.

Ritchey notes that flight tests are frequently conducted to acquire data on the entire system. If this is obtained, a test can be a success even though military goals are not all achieved.

In addition, on-board instrumentation and ground support equipment required in many flight tests are, in themselves, much more complicated and unreliable than the counterparts demanded in a military operational missile.

Since the useful life of this type of test equipment is relatively short, it is often more economical to accept a relatively low reliability in the equipment. Thus a nominal risk of flight failure can be assumed to be more advantageous for the overall program. ⌗

	XM-20 (X-17-RTV)	XM-55 MM-WING I	LR-89 ATLAS
1. NUMBER OF COMPONENTS	6	9	33
2. NUMBER OF COMPLETE ENGINE DEVELOPMENT TESTS	6	132*	3177
A) ENGINEERING DEVELOPMENT AND STORAGE TESTS	1	82*	
B) PREFLIGHT RATING TESTS	5	12	3126
C) QUALIFICATION TESTS	0	18*	
D) DEVELOPMENT FLIGHT TESTS	0	20*	51
3. ACCUMULATED RUNNING TIME TO DATE	1220 SEC	2350 SEC	155,750 SEC
4. TOTAL FLIGHT TESTS TO DATE	39	1	74
5. FLIGHT FAILURES DUE TO FIRST-STAGE PROPULSION	0	0	4
6. RELIABILITY DEMONSTRATED (90% STATISTICAL CONFIDENCE) PROJECTED AND CURRENT	95.7	98.3* 90.5	91.4

* PROJECTED TO COMPLETION OF WING I

TYPICAL TEST AND RELIABILITY records illustrate that the nature of the reliability achievement problem is closely related to system complexity and design knowledge in relation to the state of the art.

IR Spectrometer Has Striking Sensitivity

Block system developed for Air Force and now available commercially has compactness, light weight and low-power requirements suggesting it may have many uses in space

by Charles D. LaFond



HAND-HELD Interferometer Spectrometer developed by Block Associates, Inc. has been used by Air Force for missile plume studies at Cape Canaveral. The unit has gain of over 1000 in sensitivity, developers say, compared with conventional IR spectrometers.

A GAIN of more than 1000 in sensitivity over conventional infrared spectrometers has been achieved by a conceptually new infrared spectrometer developed by Block Associates, Inc. of Cambridge, Mass.

The system is compact, lightweight and low-powered. Its portability and unusually high gain suggest a variety of potential uses: celestial research, meteorological studies and geodetic research from the ground or in flight, plasma research, and remote high-accuracy temperature measurement. Many of these applications already are being planned by the Air Force.

One of the first to use the hand-held version of the spectrometer was the Geophysics Research Directorate (GRD) of Air Force Cambridge Research Laboratories. Engineers there employed the system successfully to measure and analyze infrared radiation from missile plumes at Cape Canaveral.

A gunstock-mounted model of the instrument continued to obtain spectral data even after much larger conventional spectrometers lost the missile, Block said.

A two-package commercial version of the spectrometer is now commercially available, the company said. It consists of an optical head and separate electronics with a selection of IR detectors. Cost, said Block, is about $4500 for a complete instrument.

• **New analytic tool**—Infrared spectroscopy has developed into one of the most powerful analytical tools. In the present state of the art, however, its use has often been limited by inadequate sensitivity.

To overcome this as well as other limitations, and thereby extend the application of IR spectroscopy, Block, under partial sponsorship of GRD, developed the techniques of interference spectroscopy, then reduced them to practical laboratory and field instruments.

The interferometer spectrometer evolved from this development work achieves its very high sensitivity in part by making more efficient use of the measuring time. All wavelengths are examined simultaneously, instead of singly as in a conventional spectrometer, the company said. Also, the device does not require the narrow entrance slit usually employed, and this enables it to accept more radiant energy from the source.

• **Advantages numerous**—The advantages of this instrument as compared with standard dispersive spectrometers (prism and grating types) of equivalent resolution (40 cm^{-1}; i.e., 0.004 microns at 1 micron) include:

1. 1000 to 10,000 times more sensitivity when examining extended sources,
2. Light weight, small size, and low power consumption.

3. Rapid scan: 4 spectra/second can be accomplished with the present instrument. (Even if this scan rate is not fast enough for a particular very rapidly fluctuating source, Block asserts, the interferometer still shows the correct relative shape of the spectral distribution. The only loss is in resolution.)

4. Capability of using two different detectors to simultaneously cover a very broad spectral region in one output channel. This is equivalent to having a single detector which has the composite characteristics of the two detectors.

5. No problems with any overlap of wavelengths or spectral orders; broad spectral regions can be handled conveniently.

The system apparently offers a great deal of flexibility. It can be used with a variety of fore-optics systems to provide any desired field of view, a company engineer said. Also, when a point source is being examined, exact aiming of the system is unnecessary, since there is a large entrance aperture into the spectrometer.

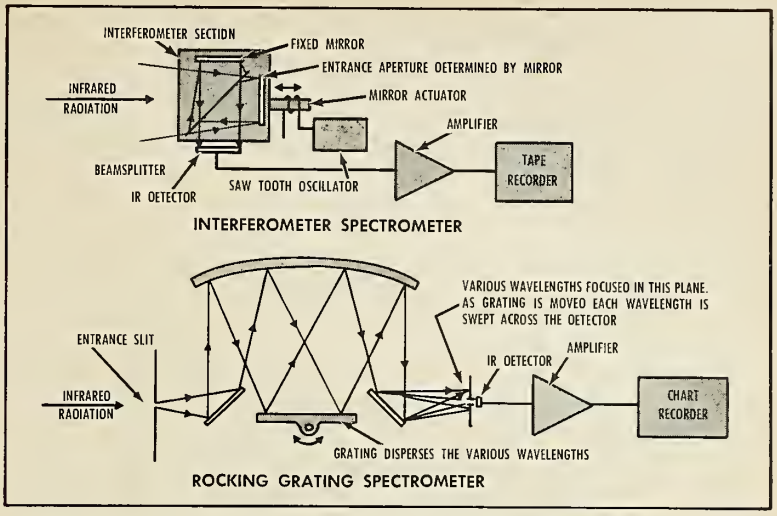
The spectrometer, he said, can be used with detector arrays to examine many parts of the total field of view simultaneously. Finally, it can be used with reticles for space filtering to permit separating point sources from the background.

• **Principle of operation**—A Block official recently outlined the operating principle of the new spectrometer with an acoustical analogy. If one has a sound to be analyzed, he said, it is first picked up by a microphone and then the output from the amplifier is recorded on tape. The tape can be played through a wave analyzer to show the amplitude of each frequency component in the sound.

This same procedure could be used to analyze infrared or other electromagnetic radiation—if detectors were available that were fast enough to follow the fluctuations of the electromagnetic waves. However, an interferometer can be employed to slow down the waves.

The process, he said, is analogous to obtaining slow motion in a movie projector. The interferometer can be considered as making a picture of the wave trains of light. This picture is the fringe pattern produced by the interferometer. When one of the mirrors in the interferometer is moved back and forth at a slow, constant velocity, the "camera" becomes a movie projector; the "picture" moves. The motion is manifested as an alternate brightening and darkening of the central fringe.

An IR detector placed at the central fringe converts these cyclic changes into an alternating electrical signal. If the mirror velocity is kept constant at a predetermined value, said the Block spokesman, the frequency of the a-c signal out of the detector is directly related to the wavelength of incident radiation, assuming for the moment that the incident radiation is at one given wavelength (monochromatic).



COMPARISON of Interferometer and Rocking-Grating Spectrometers.

If another wavelength twice as long as the first (hence half the frequency) should be substituted as the incident radiation source, the a-c output signal from the detector would be at one-half the frequency of the first. The amplitudes of the two signals would remain the same if the maximum brightness of the two sources were the same.

If incident radiation containing many wavelengths were introduced into the system, the output of the detector would consist of a superposition of all the a-c signals which correspond to all the wavelengths in the source.

This superposition of many a-c signals is the same thing that happens in a microphone when the incident sound consists of many notes.

The electrical outputs of the microphone system and the interferometer-detector system are equivalent. Consequently, the same procedure of using tape recording and playing it back through an audio wave analyzer permits the infrared spectrum to be recovered just as the acoustic spectrum is recovered.

Mathematically, it can be considered that the interferometer takes the Fourier transform of the incident radiation, and the wave analyzer takes the inverse transform.

• **Data reduction**—The use of a tape recorder and wave analyzer combination is the simplest way to convert the superposed frequencies (called an interferogram) back into the original spectrum.

The paper-feed of a chart recorder is mechanically linked to the frequency tuning control of the wave analyzer; as the paper slowly advances, the frequency is changed. This produces a spectrum which has as its abscissa a scale that is linear with frequency (or wavenumber).

Data reduction is not limited to use of the above procedure. If it is desired, the interferogram can be converted into digits and the inverse transform calculated on a computer.

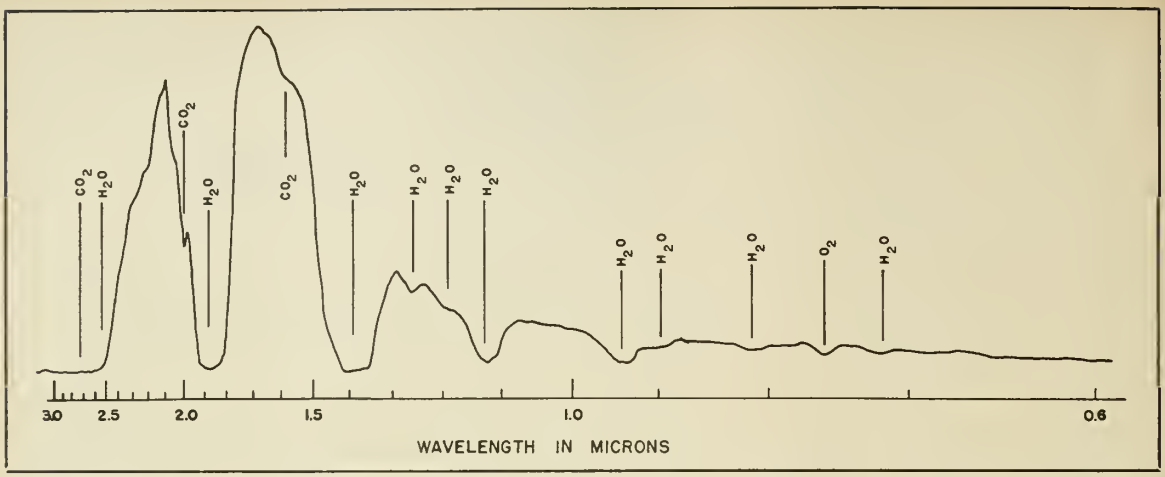
The fact that each wavelength of the source appears as a different electrical frequency permits the use of several additional methods of data display. If a spectrum is desired without going through the delay of tape recording and wave analysis or computer programing, this can be accomplished by feeding the output of the spectrometer directly into a panoramic wave analyzer.

If the interest is only in a few wavelengths, several tunable narrow bandpass filters can be placed in the output. These would continuously indicate the energy level of each of these wavelengths.

• **High gain vs. time**—The most striking advantage of interference spectroscopy over conventional techniques is the large gain in sensitivity. This comes about from two factors, according to Block:

—The interferometer has a much larger entrance aperture. It is determined by the mirror size, whereas conventional instruments are limited by slits. Essentially, the product (entrance angle x area), which might be called "throughput," is much higher in an interferometer. For typical instruments, this can be a factor of 100 greater than in a conventional spectrometer.

—The interferometer spectrometer examines each wavelength throughout the entire time period of each scan. In a conventional instrument, each wavelength is examined for only a very short



SPECTRUM OF MOON obtained by interferometer spectrometer under the following conditions: PbS detector; 8-cm aperture, glass optics; 1.5° field of view; 6 seconds recording time at 3 scans per second; approx. 54 cm^{-1} resolving power.

part of the scan time (1/n th the scan time if n is the number of resolution elements). A basic theorem of information theory shows that signal-to-noise increases as the square root of the measuring time; hence, an interferometer achieves a gain which is $n^{1/2}$ for the same scan time. For typical instruments this can be a factor of 50. Furthermore, this gain is realized even when examining point sources where the throughput gain is not large.

The price for these gains is dependent on the data reduction method. If the tape loop and wave analyzer are used, it is necessary to wait until the wave analyzer has been tuned through the entire range of frequencies which correspond to the spectral region of interest. Here, gain is paid for with a time delay in the order of 15 minutes for data reduction—that is, plotting the spectrum.

If a panoramic wave analyzer is used, the presentation is immediate, but the resolution may be limited.

• **Broad usage planned**—Several applications for the Block instrument are currently being implemented or are in the planning stage by GRD in Cambridge.

Balloon- and aircraft-borne instruments will be used for measurements of infrared energy radiated by the earth. Because of the sensitivity of the instrument, these measurements can be accomplished conveniently, using the lower-sensitivity long-wavelength detectors such as thermistor bolometers.

The spectral region from 4 to 40 microns will be of primary interest in this program. This will provide information concerning the outward-radiated portion of the heat balance of the earth. Data obtained will help to improve the understanding of the atmosphere and thereby to improve long-range meteorological predictions. Also, this measurement will provide general information on the earth as an infrared background. This is of special importance in the design of various types of military surveillance systems.

Other measurements by these balloon-borne instruments are planned to determine the variation of width and attenuation of certain spectral absorption lines characteristic of the water and carbon dioxide in the atmosphere. Since these characteristics vary with temperature, this provides a method for obtaining a temperature profile of the atmosphere as a function of altitude.

The small size, light weight, and low power consumption of the instrument, Block believes, make it possible to go to altitudes of 120,000 ft. with standard balloons—instead of the usual 90,000-ft. limit imposed by the weight of heavier conventional instruments.

A study of the infrared transmission of the atmosphere at night is another program. Most of the existing atmospheric transmission data are obtained by pointing a spectrometer at the sun and measuring the spectral absorption due to the atmosphere.

However, the properties of the atmosphere change with temperature; hence it is desirable to determine these at night by using the moon as the source. This is difficult with conventional spectrometers because of the low intensities of the radiation reflected from the moon.

The study of radiation from aurora is another example of work with weak sources. This information is needed to aid our understanding of these phenomena. It is of major significance in radio communication on the earth as well as from the earth to space vehicles.

Analyzing the radiation from various stars, planets, and nebulae is still another field for exploiting the instrument's high sensitivity coupled with its large pointing tolerance, which overcomes the problem of atmospheric scintillation. This scintillation causes a point source to move about in the focal plane of a telescope—thus making it very difficult to image it onto the narrow slit of a conventional type of spectrometer.

In addition to these applications, a number of other measurement projects utilizing the Block Associates' interferometer spectrometer are being considered by GRD. These programs, which will increase overall knowledge of the atmosphere and the solar-terrestrial relationship, include: measurement of solar flux and high-energy particles, study of scattered solar radiation in the upper atmosphere, investigation of the composition of the atmosphere, and study of night air glow.

In many of these programs, it is possible to make measurements from various locations (using anything from ground-mounted telescopes to balloon-borne platforms) with the same instrument. This will make the correlation and comparison of data relatively simple and quite reliable, Block said. ⌗

F-1 to Get LOX from Big Air Force Plant at Edwards

A 2000-TON LOX storage plant is nearing completion at Edwards AFB, Calif., for the *F-1* engine test program.

The plant, about a half-mile from the F-1 test stand, is being built for the National Aeronautics and Space Administration. NASA will obtain LOX for the plant from the Air Force when the facility goes into operation this summer.

The LOX will be carried to the test stand in a vacuum-jacketed pipeline. The facility is a half-mile from the stand for safety. ⌗

Space Power from Microwave Energy?

Feasibility of conversion reported at NAECON's big annual meeting; highlights from other papers presented

DAYTON, OHIO—The conversion of ground-emitted microwave energy for electrical power in space stations has been proved feasible.

This conclusion was presented by L. E. Porter of the Air Force's Wright Air Development Division (WADD) before the 13th National Aerospace Electronics Conference here recently.

Using state-of-the-art microwave tube technology, Porter said, converters have been built with efficiencies up to 32%. These were operated at 1290 mc with 240-kw peak input power. Work will continue, Porter asserted, to further increase efficiency. Also, more studies will be made to determine the variation of power and frequency, to investigate the feasibility of high-power continuous-wave operation, and to obtain a more complete understanding of the interaction phenomenon.

It is possible, said the WADD scientist, to envision a space platform powered by directed narrow-beam microwave energy. Indications are that even the present rf-to-dc (or low-frequency a-c) power converters can be improved readily to efficiencies of from 60-70%.

Investigations so far have shown that at least five different approaches for converters would be feasible: cross-field, linear-beam, plasma, cyclotron-resonance, and diode types. Only the crossed-field energy converter has been built and tested so far, Porter said.

(Much of the basic research in this field has been performed under an AF-WADD by Raytheon Company at its Microwave and Power Tube Division.)

• **Attendance low**—Fewer than 2000 persons attending the National Aerospace Electronics Conference (NAECON) gathered at the Biltmore and Miami Hotels for Dayton's annual 3-day technical spree.

The available 120 booths for exhibits were filled with over 70 major missile/aircraft electronics manufacturers.

A highpoint in this year's meeting was a classified session held at the Wright Field Auditorium. Five WADD experts presented a detailed look at the future role of electronics in military aerospace systems.

Moderator at the secret session was John Keto, WADD's chief scientist. Panelists and topics were B. Chasman—advanced electronics systems, Col. W. S. Heavner, USAF—reconnaissance trends, J. M. Ferguson—electronic propulsion, A. Goldman—advanced space systems, and H. Behrens—*Dyna-Soar* requirements.

• **Technical papers**—Roughly 100 papers were delivered at the 20 technical sessions. Among their highlights were the following:

—Velocity and range information along a radar-beam system with respect to terrain can be obtained simultaneously, said L. P. Schnepper of Raytheon's Missile and Space Division. It has been proven theoretically, he said, that such data can be collected with a single radar and interaction between the two portions of the radar signal can be prevented.

—The problems of successfully propagating radio energy through the ionized sheath enveloping hypersonic vehicles were outlined by R. Rawhouser, AF-WADD. A side problem limiting such studies, he said, is the difficulty in simulating the necessary environment in the laboratory.

Missile flights help, but they are too few. *Dyna-Soar* will be an effective instrument for obtaining valid data, but the information should be available to assist in the development of such a manned space vehicle.

Rawhouser described four approaches to reducing plasma effects on communications:

(1) Direct cooling of the vehicle region containing the antenna with water or steam injection into the boundary layer,

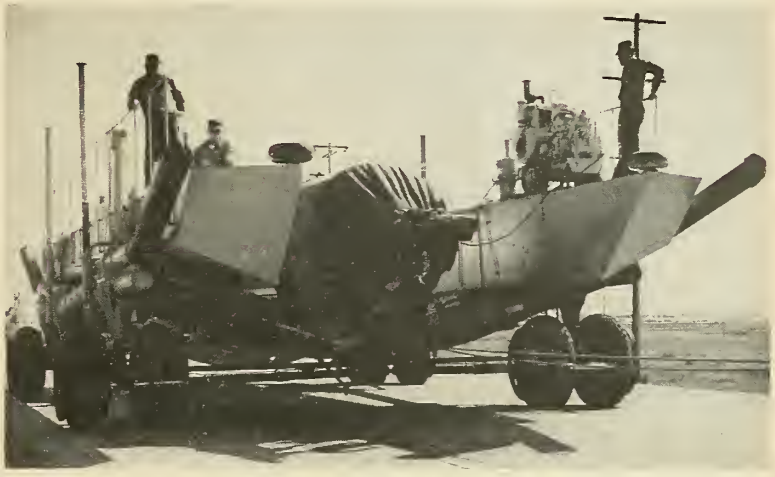
(2) Modification of shock region by gas injection into shock wave.

(3) Use of an electron beam and the plasma itself as the radiating element, or

(4) Use of a strong magnetic field to "guide" electro-magnetic energy through the plasma. The latter method appears most promising, the author said.

—An improved method for magnetohydrodynamic (MHD) gyroscopes was detailed by R. V. Monopoli, Speidel Corporation. The development of such a sensor, he said, was undertaken by his company's R&D Division on the basis of proposals by Dr. P. F. Maeder of Brown University. The author described an apparatus for measuring Coriolis forces using MHD methods.

The advantages of an MHD gyro, he said, are that they will avoid problems of mass unbalance and bearing friction and wear. ⁂



For Sea Surface Launching

HYDRA II MOCK-UP VEHICLE being readied by the Navy for personnel training and sea-handling tests. Mock-up missile is carried in amphibious R3Y vehicle used to transport on both land and sea. Hydras will be launched directly from an upright floating position in the water, with no pad or gantry required.

Transducer Field Demands Standards

Waste, high costs, uneven reliability and strain on vendor-customer relations plague industry today

by Harry N. Norton*

THE TRANSDUCER field today suffers from an accumulation of ailments curable only by a strong purgative.

The medicine—Standardization—is not new; the treatment is not painless. The remedy, however, can be extremely effective when administered forthrightly and without restraint.

The use of test instrumentation by the aircraft—and especially the missile and spacecraft—industry has been increasing at an extremely rapid rate during the past few years. The cost and complexity of the new vehicles and their operation require a maximum number of measurements to be made on a minimum number of ground and flight tests.

Measurement requirements have become steadily more difficult to meet with the transducer types available.

The expanding demand for new, reliable, accurate transducers of various types has brought about the creation of a multitude of new designs by established transducer manufacturers, as well as the entry of scores of new manufacturers into the aerospace transducer field.

Simultaneously, transducer users were faced with a manpower shortage in their many added instrumentation functions. A large portion of the vastly increased personnel engaged in various phases of transducer work therefore still lacks sufficient background, training and skill in this highly specialized field.

• **Diagnosis clear**—The existing sickness in the transducer field is rooted in three major problem areas: the user's uncertainty concerning actual measurement and environmental requirements; the user's confusion regarding optimum selection from a multitude of new transducers including many insufficiently tested designs; and the instrument maker's difficulties in attempting to satisfy the wide variations in transducer specifications.

The resulting duplication and waste of effort, high costs, doubtful reliability—as well as the strain on vendor-customer relations—have been extensively discussed in cognizant government and industry branches. Wherever solutions are being sought, a constantly recurring word is "standardization."

The desire for standardization is quite natural. Most fields of human endeavor, and particularly technical fields, reach a stage of development where agreement must be reached on terminology, performance requirements, and perhaps dimensions and general operating characteristics. Standards will usually originate at that point of the progress curve where this curve begins to flatten—i.e., where the ratio of past progress to future progress becomes large.

Standardization of some selected portion, aspects, or characteristics of a product can be helpful at an even earlier point on the progress curve. Recognition of the relative magnitudes of past and future progress is, of course, a primary prerequisite to choosing the time for initiation of standards.

• **Remedy safe**—To those familiar with the magnitude of recent progress in transducer development, it is quite clear that this time has now been reached in the case of certain general fundamentals and a limited number of specific transducer types.

Standardization can be started now—without fear of stifling future development—if the standards are kept flexible, if they are subjected to frequent revisions, if they are limited to high past-future progress ratio items, and if their possible complete obsolescence is borne in mind.

• **Terminology first** — Preliminary surveys by the Inter Range Instrumentation Group and by the U. S. Air Force's Aeronautical Systems Division have shown that the primary need for standardization of aerospace transducers exists in the area of terminology.

At the present time, many users and quite a few transducer manufacturers have their own glossaries or lists of definitions, each differing from any other on many terms. A few definitions appear in encyclopedias and glossaries published by technical organizations; however, most of these are too general, too academic, or too complex for acceptance by personnel at the working level.

The major portion of aerospace transducer work is performed on government-sponsored projects by personnel of varying education background, responsibility, skill and experience. It is not in the national interest to have terms they use defined in such a manner that they can be readily understood by only a few.

Simplified terminology must be developed, therefore, for the specific purpose of clearly defining performance parameters and some additional important fundamentals of aerospace transducers. Wherever possible the definitions should be no longer than one sentence. If necessary, only one of several general definitions should be selected if this serves the specific purpose under consideration.

Considerations of frequency of usage may show, for example, that many of the twenty-odd varieties of linearity (or non-linearity) may not have to be included in a simplified terminology standard. The conflicting usage of synonyms such as "input, stimulus, measurand" and "input, power, excitation" should be resolved to the inclusion of only one of these terms and cross-referencing the others to the one selected.

Nomenclature deserves particular, immediate attention. The main source for officially recognized names of government-procured items, the Federal Supply Handbook, lists only a "transducer, motional pickup" for physical measurements and seems concerned primarily with transducers as sources of acoustic energy.

It is difficult to guess that colloquial terms such as "strain gage," "pressure strain gage," "strain gage pickup," "bonded pickup," "bonded transducer," "pressure pickup" may all refer to a strain-gage-type pressure transducer. If a temperature transducer transduces temperature, does a "force balance transducer" transduce force balance? How many readers of instrumentation reports know that a "stick-on" is a surface temperature transducer?

*Mr. Norton is a senior instrumentation engineer concerned primarily with transdueer development at Convair Division, General Dynamics Corporation, San Diego, Calif. Besides being a prolific author of technical articles and society papers, he currently is directing the nationwide government-user-vendor committee of the Instrument Society of America organized to establish transducer standards.

Unified nomenclature, acceptable to users, manufacturers and—particularly—cognizant government agencies, will have to be established in the very near future.

• **Performance specs next**—Specifications, especially those portions referring to performance characteristics, are some of the most potent sources of confusion to virtually all personnel in the areospace transducer field.

Misinterpretation of users' as well as vendors' specifications has already wasted thousands of man-hours and hundreds of thousands of dollars, according to very conservative estimates. While many of the past losses must be written off to the general learning curve, sufficient knowledge exists at this time to reduce greatly any further losses due to poorly-written specifications.

There can be as many interpretations of the meaning of "Accuracy: 0.5%, min." as there are people reading it. Tolerances for hysteresis may or may not include the sometimes very large eeffcts of statis friction in potentiometer-type transducers. Some specifications do not even mention vibration effects, others may omit numerical tolerances.

Line-pressure variation, not usually noted in specifications for differential pressure transducers, may cause errors in the order of 10% of full scale. "Frequency Response: flat to 2000 cps" is meaningless unless an amplitude error tolerance such as "within ±0.5 db from the amplitude at 100 cps" is added.

• **Testing weak**—Test procedures are closely connected with specifications. Improper test methods have defeated the purposes of many otherwise well-written specifications.

Performance characteristics can vary over a wide range depending on the method used for their verification; however, the lack of standard or at least mutually-agreed-upon test procedures has led to vendors' loss of business, users' embarrassment, multiple duplication of effort, and invalid data on vehicle performance.

Time-constant determination of temperature transducers may yield different data depending on viscosity, conductivity, and agitation rate of the liquid used for immersion. Vibration effects can appear to be very small if only d-c shifts are measured. In searching for temperature effects the stabilization time is quite critical. The number of measured points necessary for valid calibration data is a matter of great controversy.

Little consideration is given to preventing human errors. Data sheets may be difficult to interpret. Lengthy pages of comments can be used to make the importance of poor performance data seem negligible.

Glass Case For Polaris



EXPERIMENTAL POLARIS glass-wrapped motor is more than 14 ft. long with a 4.5-ft. diameter. Built by Aerojet-General, the motor is largest glass chamber ever fired. The case is part of the Navy's 2500-mile Polaris program.

Standard test procedures would offer an ideal solution to the dilemma in which minor users of transducers frequently find themselves, particularly if they lack adequate facilities. They are often faced with the choice of either trusting a specification or trusting an outside facility with performing a test per a sometimes loosely written procedure. Their problem may be aggravated by insufficient funds and their inability to evaluate test data properly.

The economic picture really does not look much better for vendors who are requested to write a different test procedure for each customer, and for major users who have to expand man-hours on evaluation of vendor-written procedures, on co-ordination with outside test facilities, and on possible re-runs of tests at their own facility.

The effectiveness of standard test calibration procedures could be increased by inclusion of readily available standard report blanks and data forms. Interpretation discussions and human errors may be minimized by enforced use of forms which are so designed that presentation of essential data is optimized when applicable columns and lines are filled in completely and affected blocks are checked off. Title pages of reports can become less decorative and more useful if they consist primarily of a summary table which simply shows what tests were either passed or failed.

• **Design problems**—In addition to terminology, nomenclature, specifications of performance characteristics, test procedures, and test reports, there are several design characteristics which could be standardized for a number of commonly used transducers with great benefit to both users and manufacturers. These include electrical connections and wiring diagrams, drawing symbols, nameplates, excitation requirements, fluid connections such as pressure fittings, and perhaps even selected mountings and configurations.

It may also be desirable, in the not-too-remote future, to create standard sheets for "preferred types," similar to "AN," "MS," or "NEMA" standards, with a "use-when-adequate" connotation.

• **Treatment difficult**—Standardization work on aerospace transducers will be a difficult but necessary task.

It will require wholehearted support from government agencies and the using as well as the manufacturing industries. It will demand concentrated and persistent effort from the limited number of instrumentation specialists whose background enables them to make substantial contributions to such a project. Essential to their work will be generous sponsorship by their employers.

The gains made possible by transducer standardization will soon become apparent in dollars and hours saved, improved data and better relations between manufacturers and users. The reduction in everyday hardware problems will facilitate work on new developments and help speed necessary improvements in the state of the art. ⌘

Weightlessness Lowers Performance

Tests at Aerospace Medical Laboratory foretell some problems for astronauts in maintaining tolerance to severe stress



PEERING EERILY from water tank, an Air Force subject tries various maneuvers in a condition simulating weightlessness.



PHYSIOLOGICAL changes occurring when muscles are not used for long periods of time are monitored by Capt. Graveline.

by Heather M. David

WEIGHTLESSNESS may lower man's stress tolerance even quicker than was previously thought.

A class of eight Air Force men who were submerged in water tanks in a simulated "weightlessness" condition found that some physiological changes occur as early as 6 to 12 hours.

Most important, the subjects did not perform as well on the centrifuge, tilt table and in heat tests after submersion as they did before. This may pose a real problem in spaceflight, when the pilot receives the greatest g forces and heat during re-entry.

Directing the tests at the Aerospace Medical Laboratory, AFSC, Dayton, Ohio, is a man who probably holds the record for the longest period of "weightlessness" at a stretch.

Capt. Duane Graveline, who last year spent a week in a water tank at the Brooks AFB Aerospace Medical Center, experienced significant muscular and skeletal deterioration towards the end of his ordeal. He even found walking a shaky experience when he finally emerged.

The Dayton group is trying now to pin-point when these changes occur and what man's exact needs are for exercise, sleep and food. The laboratory has just completed a 9 x 6.5 x 7 ft. tank which it is using for the tests.

The subjects recline on couches in the water with restraining straps to keep them from rising to the surface. Water temperature is kept at a pleasant 90-92°F, which the men feel as neither warm nor cold.

Electrocardiograms and electroencephalograms are taken by electrodes under the armpits and head of each subject. Air, food and water are supplied through tubes into the waterproof helmet, which is individually tailored to fit each man's neck.

Even the food is somewhat like a spaceman's provisions—semi-solids supplied from squeeze tubes.

• **Loss of strength**—The weakening process is marked by increased kidney activity, since calcium, phosphorus and other minerals leaving the bones and muscles are eliminated in urine. This increased output was noted even in short-term runs.

The researchers also found that this output could be decreased by exercising the subject and by the use of posterior pituitary hormones. Carefully designed exercises will be needed for periods of weightlessness lasting more than a few hours, most aerospace doctors agree.

Also noted in the current studies is a tendency to dehydration in the blood cells and an increase in blood hemoglobin concentration. The exact significance of this is yet to be determined.

Not yet under way at Dayton is a sleep evaluation program. A surprising thing emerging from Capt. Graveline's own experience was that he needed only about seven hours sleep in the entire week. Dayton doctors report that on the day-long runs they have noticed the subjects tend to fall asleep during the first few hours, then remain awake during the rest of the time.

• **Psychological studies**—Another important phase of the program is a battery of psychological studies on isolation and the effect of various forms of sensory input. Capt. George Barnard of the Aerospace Medical Laboratory head this project.

All eight volunteers have been carefully examined both physiologically and psychologically to get base-line measurements. Upon emerging, each subject recounts his feelings and thoughts to the psychiatrists.

Some of the subjects found the experience very exhiliarating. They hummed and whistled. When they got out of the tank they felt very bad and wanted to return.

The wildest hallucinations were experienced by those who had the least outside contact during their stay in the tank. One man even saw a rattlesnake in the water, but he was able to talk himself out of it. Others had trouble concentrating or remembering things. Some panicked when they awoke in the unnatural atmosphere.

And although spacemen may not have the luxury of television in their initial journeys, the Air Force is using it to find out how a man otherwise isolated reacts to this kind of stimulus. ⁂

(Continued from page 17)

the State Department? Other government agencies are certain to be affected. What voice will they have?

• **Conventional legal problems**—Private companies that own or operate satellite communication systems will expose themselves to new kinds of legal liability. In the first place, they may become liable for personal injury and property damage caused by launching accidents or the flight or landing of satellites. Remember the recent fall of fragments from the vehicle of a *Transit* navigation satellite last November on eastern Cuba. Numerous incidents of this kind have occurred, and will certainly become more common as more and more satellites are launched from the earth's surface.

Manufacturers may be sued for damages resulting from defective parts. At an earlier stage of the industrial process, companies may be held liable for accidents that occur in the course of research and development, manufacturing, testing or handling. For example, rocket fuels are highly explosive, and may cause blast or fire damage. The operation of communication satellite systems may also involve other forms of liability arising from radio interference, libel or slander.

Such legal problems will be international as well as domestic.

Private companies that enter the satellite communication business may also run afoul of the antitrust laws. Should the government give a favored position to any one company? A favored position might become a monopoly if, as many people believe, only one communication satellite system could be run at a profit.

According to a letter of February 20, 1961, from the antitrust division of the Justice Department, "competitive considerations require that no one firm dominate satellite communications."

Some companies have proposed a "common carrier's common carrier"—that is, a joint venture providing service to all international communication companies desiring to use the channels of the system. It would also be possible for the Government to operate communication satellites just as it runs the Post Office.

• **Washington policy**—What is our present national policy concerning satellite communication systems?

Shortly before he left office, President Eisenhower stated that the Government should "aggressively encourage private enterprise in the establishment and operation of satellite relays for revenue-producing purposes." President Kennedy has not yet announced his policy, though he has said that this country would like to cooperate with the Soviet Union in several fields of space technology including satellite communications. Clues can be found, however, to the probable attitude of the Kennedy Administration.

The report to the President-elect of the ad hoc Committee on Space (the "Wiesner report") proposed that the Government set up a special organization to direct federal support of private space activities. This proposal evidently presupposes that space activities will be conducted by private enterprise, and will be directed and supported by the federal government. Furthermore, a staff report issued by the Senate Committee on Aeronautical and Space Sciences, formerly chaired by Vice President Lyndon B. Johnson, recently warned against "lending support to the image which often develops abroad—and which the Soviets would try to exploit—that any United States program of space relays would simply enrich the private communication interests."

The FCC and NASA have recently sanctioned the private development and operation of communication satellites. in a joint "memorandum of understanding" issued on March 15, 1961, the two agencies stated:

"In accordance with the traditional policy of conducting international communications services through private enterprise subject to governmental regulation, private enterprise should be encouraged to undertake development and utilization of satellite systems for public communications service."

The memorandum also referred to the "fact" that "at the present time overseas voice communications are provided primarily by a single company." The "single company" is AT&T, which operates the submarine telephone cables. In effect, this memorandum continues the Eisenhower policy favoring private communication satellites.

• **On our way**—In 1959 the International Telecommunications Union (ITU) allocated 6 radio frequency channels (in the 890-16,000 MC. range) for experimental space use, effective 1 May 1961. The ITU is scheduled to hold a special plenary session on satellite and other space communications in 1963. Observers predict that some foreign countries will not easily be persuaded to stop using certain frequencies in order to release them for space communications.

In 1960 the Federal Communications Commission (FCC) held hearings on frequency allocations for space satellites. Several private companies had asked for the reallocation of frequencies above 890 MC. for space use only. The FCC decided that "in view of present uncertainties, specific allocations for space communications cannot be made at this time" (FCC Report No. 751, September 29, 1960). The American Rocket Society has appealed from this decision to the U.S. Court of Appeals for the District of Columbia. Its petition for reversal states that the decision "vitally and adversely affected the allocation of radio frequencies for use in space activities."

In fact, a few frequencies (rather than broad bands) may prove to be sufficient for space use. Exclusive frequency allocations may not be necessary at all, except for services involving safety. There is a difference of opinion on this question, even among companies that plan to use communication satellites. True, a large number of low-altitude satellites may need exclusive frequencies. Earth-synchronous satellites, however, in 22,300-mile orbit, could probably share frequencies with land systems. (On the other hand, they would require very precise control as well as larger rockets than are now available.) Whether exclusive space frequencies must be allocated will thus depend on what kinds of communication satellites are eventually adopted.

Perhaps some firmer answers will emerge from the long-range FCC inquiry now being made into the frequency allocations required for space communications (Docket 13522).

In its decision of September, 1960, the FCC not only refused to set aside frequencies for space communications, but instead opened up frequencies above 890 MC. to private users for point-to-point communications on earth. Thus these vital frequencies would become available to banks, private shipping lines and other commercial companies. Commissioner T. A. M. Craven dissented, saying that the decision shows a "lack of long-range vision" and "fails to take into consideration the revolutionary effect which the future use of satellites will have on the lives of populations of the entire world, let alone citizens of this country, in terms of national and international communication, information and propaganda."

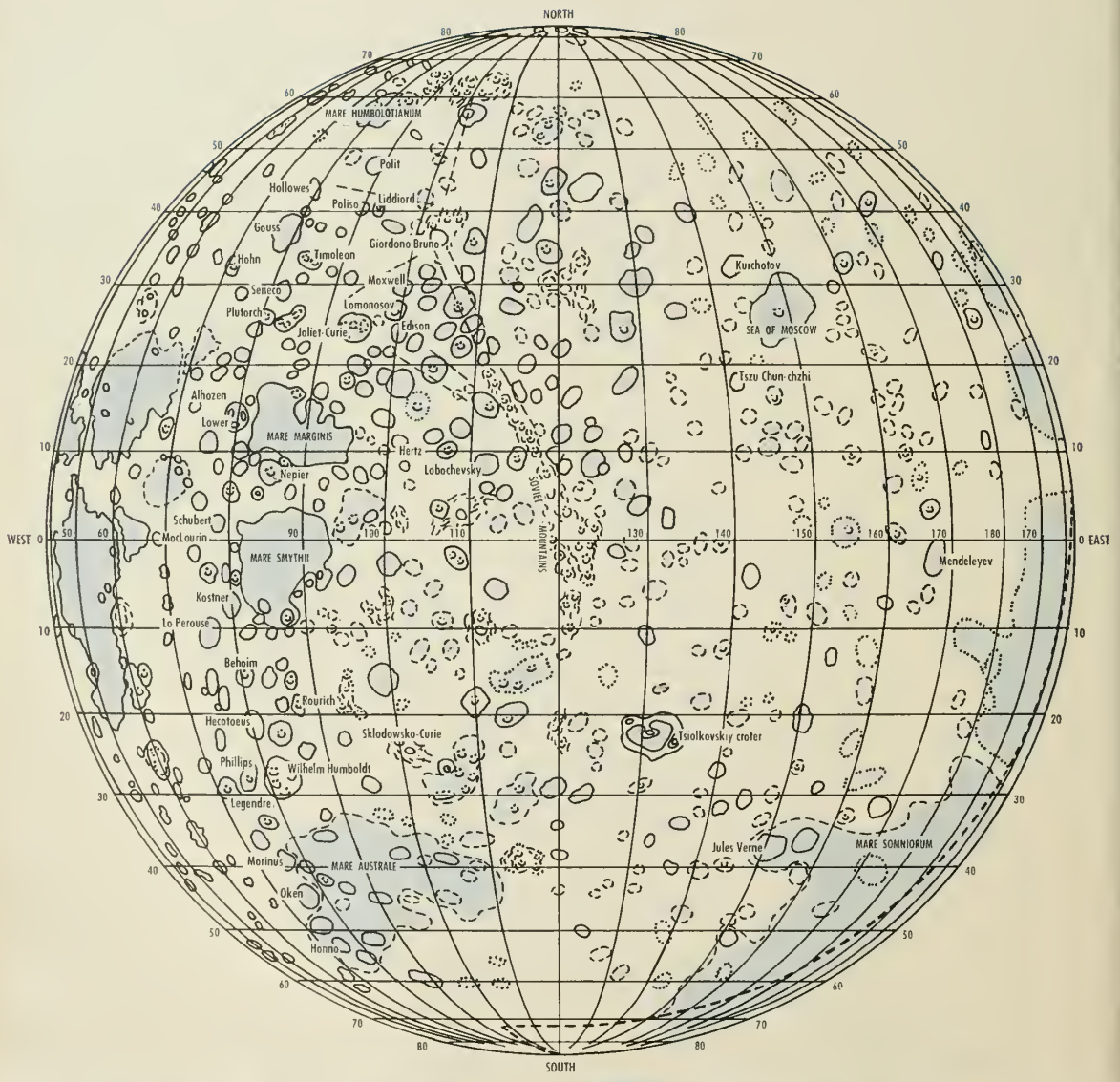
A number of private companies—including the American Telephone and Telegraph Company (AT&T), the International Telephone and Telegraph Company (IT&T) and the General Electric Company (GE)—have shown interest in commercial satellite communications.

For example, AT&T has announced plans for using some 50 satellites to relay telephone conversations and television programs between the United States and Europe. It is already designing a satellite, and says it could begin test transmissions within a year. The FCC has assigned two radio frequency channels to AT&T for this purpose (4100-4200 MC. and 6325-6425 MC.,

(Continued on page 53)

Details of first chart . . .

Russian Map Shows Moon's Fa



Reliable formations with distinct outlines

Formations with less distinct outlines

Formations whose outlines require further revisions

Formations darker than surrounding background

Formations lighter than surrounding background

Light rays

Limits of visibility

Side May Be Best for Landing

by William Beller

THE MOON'S far side may be the best place for lunar spacecraft to land.

At first sight, this pock-marked surface appears to offer cold comfort to craft seeking to come down on a firm, smooth terrain.

By contrast, the large seas and craters on the moon's near side seem to offer regions easy to negotiate and explore. However, if these seas and craters turn out to be areas of deep, talc-like dust, as some astronomers are predicting, then pontoon-type lunar craft will have to be used or a mountain landing accepted.

On the other hand, the Soviet map of the moon's far side shows no seas comparable in extent to those on the near side, and only one significant mountain chain. Thus, the far side may be hospitable to later landing craft. Early craft would not use the far side because they would lose communications with earth.

The admirable, but crude, map of the moon's far side is far from complete. Looking as though it had been sketched by an observer peering through fogged lenses, it picks up only blurred images of the terrain—and more often no images at all.

The western half of the map is by far the more reliable, particularly where the moon's librations have already given Soviet astronomers known moonmarks.

Here are some of the technical details behind the making of the map, according to a report by the Soviet's Academy of Sciences and other sources.

• **A two-eyed camera**—On Oct. 6, 1959, a twin-lensed camera mounted in Soviet spacecraft *Lunik III* shot pictures of the moon's far side for about 40 minutes. During this time, *Lunik III* was about 40,000 miles from the satellite's surface. Twelve days later, when the spacecraft was nearing its perigee, the pictures were televised from about 275,000 miles to Soviet ground stations.

Seventy percent of the moon's far side was photographed. To do this effectively, the Soviet camera took simultaneously and along parallel optical axes a series of pairs of small-scale and large-scale pictures. The diameter of the image of the lunar disk on the small-scale photographs amounted to about 10 mm, on the large-scale photographs about 25 mm.

The focal lengths and relative apertures of the two objective lenses in the camera were 200 mm and f5.6, and 500 mm and f9.5.

The Soviet report says that the camera saw the lunar disk illuminated the same way that an observer on earth would see the moon when it was nearly full. This means that the optical lenses of the camera almost coincided with the direction of the sun's rays, which lit up the lunar surface. Therefore the shadows on the moon were gone and the contrast between features was at a minimum.

The camera was loaded with specially prepared 35-mm photographic film, able to survive the trip and be processed under high temperatures. During the processing, the film was simultaneously developed and fixed and then washed and dried.

Processing for the two lens systems was done simultaneously. Thus, with a single orientation of the camera, features on the small-scale photograph which covered the moon's total disk could be correlated with details on the large-scale photograph.

When it was time to send the data down to earth, an electron-beam tube converted the negative images to electric signals by passing a light beam of constant brightness through the film. The beam moved evenly and slowly across the film; when it reached the edge, it returned rapidly to the initial position. While this motion produced line scanning, the vertical sweep was obtained by the slow and even motion of the film itself.

After passing through the film, the light beam fell on a photoelectric multiplier; its output was a voltage proportional to the varying transparency of the negative.

After amplification, the image signals modulated a high-frequency carrier and were transmitted to earth. To ensure that there would be no losses in fidelity due to the demodulation equipment, the Soviet scientists recorded the signals on magnetic tape both before and after demodulation.

Because the moon was shot at the worst possible time from a selenographic point of view—when the earth's satellite was shadowless and therefore two-dimensional—various methods had to be used to bring out the lunar detail.

One of the methods was the superposition of different frames. The Soviet reports that with strict superposition of several frames obtained under identical conditions actual features emerged more sharply, while the random noise was smoothed out.

Several types of superposition were used: simultaneous projection of several frames on a screen; projection of a positive on the positive print of another frame; and the production of "combined" prints from several negatives.

• **Amplifying a negative**—The Russian scientists say that the most fruitful method was that of "photometric sections." This allows photographic images to be selectively amplified.

For example, a zone on a negative is chosen for analysis. This zone covers a range of density contrasts and, therefore, of electrical signal amplitudes. A band of these signals is chosen to be amplified. Signals with amplitudes below the band necessarily come out black, and those above the band, white. All other signals are appropriately amplified and the images mapped.

This method permits wide amplification with relatively little noise. It is clear that the smaller the intensity range selected for conversion into an image, the larger the amplification factor that can be allowed. The largest factor the Soviet's instrument permitted was 100.

"The method of photometric section was found to be productive not only in identifying entirely unknown formations on the far side of the moon," the scientists claim, "but also in identifying formations located on the western edge of the surface of the moon visible from the earth."

The translation of the Russian report, called the "Atlas of the Far Side of the Moon," can be bought for $3 from the Office of Technical Services, U. S. Department of Commerce, Washington 25, D.C. ⁂



international

Rat Fligh

French success proves that living animal can take high dosage of weightlessness & acceleration — brain action data being analyzed

FRANCE'S successful recording of a rat's brain activity under high g and weightlessness in a sounding rocket is expected to provide new data valuable in the effort to make manned spaceflight safer.

The experiment last February proved a living animal can undergo weightlessness and acceleration to 12 g's with no ill after-effects—even a few hours after a grueling brain operation.

The rat nicknamed Hector, who performed the test aboard a *Véronique* rocket fired from Colomb-Béchar, will be exhibited this week at the Paris Air Show by the Air Research Medicine Center (Centre d'Etudes et de Recherches de Medicine Aeronautique —CERMA).

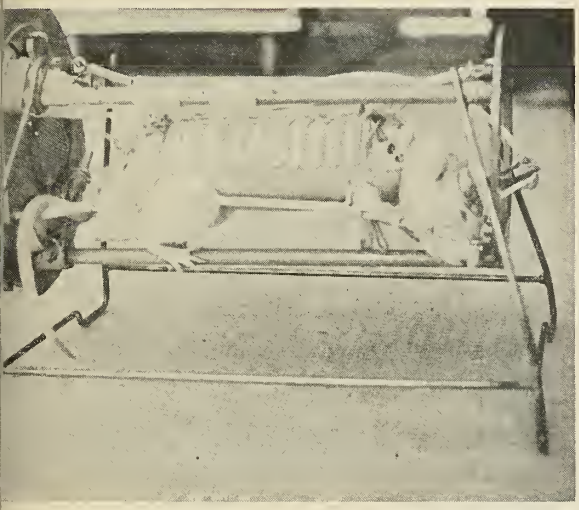
Surgeon General Grandpierre, who headed the CERMA experiment, told MISSILES AND ROCKETS that Hector was in fine health, has since fathered "petits rats" and provided needed knowledge of equilibrium and nervous systems reactions caused by weightlessness and by severe accelerations.

During a delicate six-hour operation preceding Hector's flight, holes were bored in his shaven skull to insert electrodes reaching the mesencephalic region and cortex of the brain. Other bipolar electrodes were placed in nape muscles of the neck and in the uppermost diaphragm cavity.

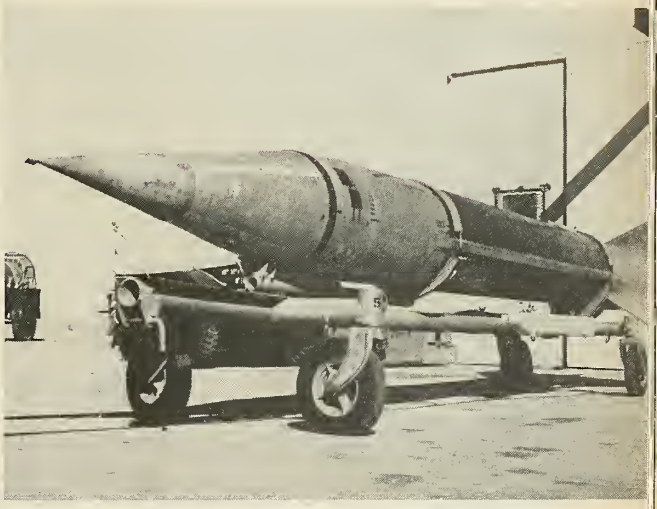
Scientists of the French National Academy of Science are studying telemetry data to parametrically analyze rhythm and brain consciousness.

"The preparation of the animal consisted, in effect, of embedding electrodes

rovides Data Encouraging for Man



HECTOR STRETCHES OUT in laced restraining frame in which he was put aboard the payload for the February firing. He is reported to be in excellent health and to have sired a family.



FRENCH VERONIQUE ROCKET of type used in Hector launch shown in horizontal position before erecting. The single-stage rocket, 24 ft. long, can carry total payload of about 132 lbs.

in selected brain positions and holding them there by special dental cement," Grandpierre said.

• **New plastic tested**—Parlaying other significance to the test, the French successfully tested a new plastic-based re-entry material by SUD Aviation and miniaturized instrumentation by the National Telecommunications Center (Centre National d'Etudes des Télécommunications—CNET).

The successful nose cone recovery terminated what may be the world's first attempt to electrically record and analyze brain waves in a space probe. The French freely admit it doesn't measure up to manned space exploits, but they hope "it will contribute to making existence during space flight safer." The final analysis is expected to be made available to foreign scientists.

SUD Aviation was called upon to develop nose cone material as shielding against temperatures ranging from −200°F to +300°F, since the flight plan called for a 135-mi. apogee, reaching Ionosphere "Layer F_1."

In a 4.6-cu.-ft. area, SUD and CNET had to install all the required electroencephalographic amplifiers, recorders and transmitters for the brain and nervous system studies.

On-board equipment recorder readings of accelerometers, internal and external temperature sensors, altimeters and vibration pickups. A new thermal valve principle was designed to maintain normal atmospheric pressure, and lithium hydroxide plates were installed to absorb excess carbonic gases.

The 2948-lb., 24-ft. *Véronique* has a normal 132-lb. payload capacity. Its single stage is fueled by a turpentine derivative with nitric acid oxidizer using furfurylic alcohol at ignition and liftoff. Acceleration and weight at burnout are 330 ft./s/s and 783 lbs.

• **Heart beat stops**—Apparently, the only modifications for this $200,000 experiment were in the nose cone area. The Hector flight was the fifth in a special series during which two of the earlier launchings resulted in explosions at the cradle.

Hector, in supporting vest and harness, was placed aboard at T-45 mins. As in most *Véronique* launchings, the gantry is rolled back at T-15 mins. and all technicians are recalled to the blockhouse. Initial acceleration was 66 ft./s/s and peak acceleration resulting from 49 secs. burning time put the rat through his paces at 12 g's.

A special timer sparked the detonation of explosive bolts for nose cone separation at T+5.1 mins., with the first chute, triggered at T+5.4 mins., slowing the descent to 197 ft./sec. A second chute maintained a 23 ft./sec. rate.

Throughout the flight, transistors amplified and transmitted the weak brain signals. Hector's heart stopped beating for about 10 secs., and all muscular reactions were suspended for almost a minute.

Although the nose cone did not penetrate beyond "Layer E," cosmic rays reddened the animal's white hair. ⌗

Joshua Produces Progress In High-energy Storable Fuel

EDWARDS AFB, CALIF.—The Air Force has just about completed initial work on its Project *Joshua*—a program of storable propellant development based on high-energy fuels.

Almost all of the project has been conducted as an in-house operation at the rocket propulsion test facility several miles across the dry lake from the Edwards Flight Test Center. Very little of the program has "gone outside" in any form.

Project *Joshua*, named after the trees which dot the Edwards area, came about in mid-1959, when applied research responsibilities in chemical rocket propulsion were switched, with some personnel, from Wright-Patterson AFB, Ohio, to Edwards. In picking up some loose ends, the high-energy storable propellant seemed promising, and engineers at Edwards decided to take a closer look.

The decision was made to use pentaborane, an outgrowth of the now-cancelled high-energy fuel program, and hydrazine. Pushing ahead despite resistance from some industrial quarters, the project staff designed and built hardware for *Joshua*, conducted its own tests and reduced its own data.

Fabrication requirements for some hardware required that the job be done outside, such as the Marquardt Corp. contract to fabricate the injectors.

First test runs with the propellant mix began in late 1959. Thrust levels of 5000 lbs. were achieved very early in the program and, to date, over 300 runs have been made at that thrust level and a specific impulse of 290 seconds has been achieved.

While the figure of 290 I_{sp} is not a spectacular one, it is very comparable with and, in some cases, exceeds that of current operational ICBM's. Ultimate goal, for which tests are just beginning is 40,000 lbs. of thrust with an I_{sp} of considerably over 300. The latter figure seems realistic in light of industry predictions that several pentaborane combinations will exceed 330 I_{sp} performance in a general time bracket of mid-1961 to 1962.

The 40,000 lb.-thrust program will continue to about July 1, then be cut off. It may be renewed in the future, however, pending certain developments the Air Force seems to expect. All components for the 40,000-lb.-thrust engine are in breadboard form—pumps, injectors and nozzles.

Engineers on the project are pleased with the results so far, but it has not been a smooth road. One major problem area was finding the proper injector design.

Original configuration incorporated a more or less standard injector face design. This led to quite a few splash plate problems. It was decided that the pentaborane/hydrazine combination needed something more unique. A shower-head system was tried without too much success.

The current approach is not available in all details, but is reported to be a pre-combustion/cups type with a triplet pattern in each cup. But it has been shown that the propellant mix seems to demand mixing in the injector.

Wetting agents and additives were tried also to reduce the surface tension of the pentaborane. Some of these were successful to some degree, others not.

Typical problem, not a new one to propulsion engineers, was scale effect of an additive. The additive boosted performance between 5 and 6 percent in a 100-lb.-thrust test motor, but chopped between 1 and 2 percent from "normal" performance on the 5000-lb.-thrust motor.

One approach may be in pre-mixed additives. In one test a slug of N-204 was used for starting and motor output went up a couple of points when the N-204 system accidently stayed on rather than shutting off after the start.

A side effect of the *Joshua* Project is a program to jell pentaborane and hydrazine and perhaps add aluminum powder. This combination would increase engine performance and aid in safe handling of the mixture. ⁂



Testing Avco's Arc-Jet Engine

ARC-JET ENGINE produces about one pound of thrust during 100-hour test-run in vacuum chamber. The 30-kw hydrogen engine is being developed by Avco for NASA and the Air Force as part of a study to determine the potential value of electrothermal propulsion for spaceflight applications.

Sperry Wins Big Contract For Ship Instrumentation

SPERRY RAND CORP. has been selected as prime contractor to instrument two C-4 vessels for use as Atlantic Missile Range tracking stations.

Twelve companies, or teams, submitted firm proposals in the heavy competition for the award. Value of the contract was not announced, but earlier estimates ran in the neighborhood of $50 million for the complete job. Final cost will be determined by negotiation.

Subcontractors have not been announced. However, the following firms were included in the Sperry bid team and will no doubt be among those named as subs: Ford Instrument Co. division of Sperry Rand, data handling and optical systems; Remington Rand Univac division of Sperry Rand, data handling; J. W. Fecker division of American Optical, optical systems; ITT Labs, communications, telemetering, data handling; Bethlehem Shipbuilding Corp., ship conversion.

Each 14,000-ton, 522-ft. ship will have a total crew of 130. ⁂

Objections to Indemnification Plan

SPACE Administrator James E. Webb encountered sharp Senate questions last week when he asked for legislation that would allow NASA to indemnify contractors against unusually hazardous risks.

Webb told the Senate Space Committee the bill he proposed would give the space agency the same authority now enjoyed by the armed services.

Sen. Bourke B. Hickenlooper (R-Iowa) objected that under the bill the government would make good any loss suffered by a contractor because of its own negligence.

Webb and John A. Johnson, NASA general counsel, told the senators the contractors otherwise would buy commercial insurance against liability at a much higher rate than would be the cost if the government adopted the policy of self-insurance. They added that the cost of the insurance premiums is eventually reflected in the cost to the government.

Hickenlooper and Sen. Clinton P. Anderson (D-N.M.), former chairman of the Joint Atomic Energy Committee, noted that the proposed provision differs from the Atomic Energy Commission's indemnity law, which provides that contractors must obtain the maximum commercial insurance available to be eligible for government indemnity, which is limited to a maximum of $500 million for any one nuclear catastrophe.

Webb said NASA is covered, as an AEC licensee, whenever it uses nuclear materials. He said he would try to work out language closer to AEC's.

The measure would eliminate the Civilian-Military Liaison Committee and give NASA the same authority enjoyed by the armed services in settling claims against the government for past infringement of patents. In cost-type construction contracts, NASA would gain the same authority as the military services and the Coast Guard to waive performance and payment bonds.

Dr. Harold Brown, director of defense research and engineering, supported the proposal to abolish the CMLC. Both Brown and Webb said the Aeronautics and Astronautics Coordinating Board, established last fall, is working well. ⌗

mergers & expansions

SUMMERS GYROSCOPE CO. stockholders were asked to approve a name change to Guidance Technology, Inc., at their annual meeting in Santa Monica recently. Summers reported earnings of $150,717 for the fiscal year, an improvement over net loss of $753,514 the previous year. Sales totalled $10.9 million, compared with sales of $7.5 million the previous year.

GENERAL ELECTRIC CO. has acquired additional manufacturing facilities for fabrication and assembly of re-entry vehicles for the *Titan II* missile at its Burlington, Vt., operation. Research and development on the Mark 6 re-entry vehicle is being conducted at the company's Missile and Space Vehicle Dept., but production will start in Burlington when research activities are completed.

DELCO RADIO has begun construction of a 150,000-sq.-ft. manufacturing building for semiconductor products ot Kokomo, Ind. The building will be completed around May 1, 1962.

THE BENDIX CORP. Pioneer-Central Division will construct a Cryogenic Development Laboratory to be operated in conjunction with a liquid-oxygen research facility that the company has maintained for 18 years. The laboratory, to be managed by Dr. Thomas Flynn, will be used particularly for applied research and development of products involving the application of liquid hydrogen.

TRW COMPUTERS CO., division of Thompson Ramo Wooldridge Inc., and the Swartwout Division of Crane Co. have entered into an agreement to provide complete automatic control systems to the chemical, petrochemical and petroleum industries.

RADIO CORP. OF AMERICA has added 20,000 square feet of production area to its Needham, Mass., plant to manufacture complete memory systems and associated components for the electronic data processing industry.

NORTH AMERICAN AVIATION has added an electro-physical laboratory to its Space and Information Systems Division at Downey, Calif. The new laboratory will conduct advanced research in electronic emissions and related fields.

NORDEN DIVISION of United Aircraft dedicated its new multimillion-dollar research-engineering and manufacturing facility at Norwalk, Conn. The 350,000-sq.-ft. facility will house 1400 employees who formerly worked in leased buildings in Stamford, Bridgeport and Milford, Conn., and White Plains, N.Y.

financial

Marquardt Corp.—First 12-week period earnings were $159,240 on sales of $11.4 million, compared with 1960 earnings of $95,190 on sales of $14.1 million for the same period.

Clevite Corp.—Sales for the first quarter totalled $22.7 million, with earnings of $1.2 million. The same period last year saw sales of $26 million with earnings of $2.3 million.

McDonnell Aircraft Corp.—Earnings were $9.1 million on sales of $260.9 million for the nine months ended Mar 31, compared with $8.8 million on sales of $330.3 million for the first three quarters of fiscal 1960.

International Telephone and Telegraph Corp.—First quarter income rose 10% with a 9% sales and revenues increase. Net income was $6.6 million, compared with $5.9 million the first quarter of 1960. Sales were $193.6 million, compared with $177.8 million.

Minnesota Mining and Mfg.—First quarter sales rose to $139.7 million from $128.7 million last year. Earnings were $16.5 million, compared with $16.2 million the first quarter of 1960.



Gas-Shielded Metal Arc Welding Gun

A simple low-cost gas-shielded metal arc welding package is available from Air Reduction Sales Co. The complete package includes a Model AH20-E Aircomatic MIGet Gun and the MIGet CAV power source. The MIGet Gun connects directly to the power source, making operation extremely simple. A single control on the power source adjusts arc voltage while a handy knob on the MIGet Gun adjusts wire feed speed. Rated at 200 amperes DC, 60% duty cycle, the power source was designed especially for the 2.75-lb. Gun.

Circle No. 225 on Subscriber Service Card

Optical Polygon

A multi-purpose tool for optically checking alignment and angular spacing in any multiple of full degrees is available from Michigan Tool Co. Model MOX-3600 is a compact, high-precision indexing device with an optical mirror mounted on its rim. It is accurate to within 0.000012 in. at a 20-in. diameter. When used with an autocollimator or similar optical sighting device, the optical polygon provides an accurate mirror surface which reflects the projected image of the sighting device's cross hairs. The amount of deviation between the reflected image and the graduated cross hairs in the sighting device gives a geometric check on misalignment, parallelism and angularity.



Circle No. 226 on Subscriber Service Card

Transponder

A transponder which doubles the frequency of the signal received from the ground transmitter and transmits in the new frequency with sufficient power to permit reception at the ground station is available from Frequency Standards. The Doppler effect is utilized to determine speed and position of the vehicle. The unit receives on 37 megacycles and transmits on 74 megacycles. Input voltage is 5.5 to 10 V; output voltage 175 V ±2.5 V. Ripple does not exceed 0.5% of the output voltage. Bandwidth at half-power reference is not more than 6 kc and not less than 1.8 kc.

Circle No. 227 on Subscriber Service Card

Code Bar Switch

A code bar switch providing octal or decimal input, mechanical code conversion, and output by binary-coded contact closures is available from Computer Control Co. Conversion from octal or decimal digit to the corresponding binary code per digit can be achieved without resorting to the multiple relay contact arrangements. The DS Series has a full ten-button decimal bank with 1-2-4-8 binary output contacts. The OS Series has a seven-button octal bank with 1-2-4 binary output contacts.

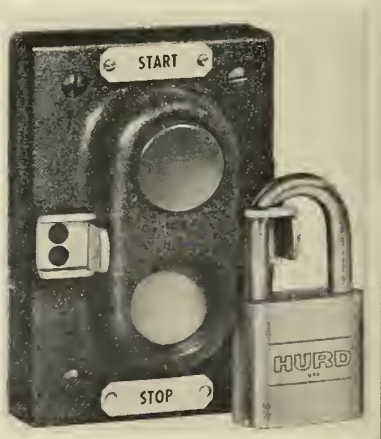
Circle No. 228 on Subscriber Service Card

Sliding Latch Switches

Two styles of electrical pushbutton switches with sliding latches for padlocking are available from Mackworth G. Rees, Inc.

The switches are designed for low-cost stop lockout protection on a wide range of industrial applications—such as conveyor systems, automation lines, complex machine tools and other processes where multiple motor drives are used and/or where the motor controls are located at some distance.

Style 3829 has a single plunger, and



is normally furnished with one set of momentary transfer contacts. Style 3827 has two plungers—a start and stop button—in a single unit.

Circle No. 229 on Subscriber Service Card

Communications Towers

A line of two-way radio communications towers ranging in height from 10 to 500 ft. is available from Motorola, Inc. The line includes eight bolted or welded guyed towers and one self-supporting model. Five of the guyed towers are of bolted, tubular steel structure. Height of the smallest is 130 ft., while

the tallest can be raised to 440 ft. Two other guyed towers are constructed of welded solid steel cross-braces of tubular legs. The two units have maximum heights of 150 and 200 ft. Towers in all seven models have a windload rating of at least 30 psf. Possible antenna loads very from one antenna for the lightest models to five for the heaviest model. A heavy-duty bolted angular steel tower which can be raised to 500 ft. with 40 psf windload rating will support five antennas.

Circle No. 230 on Subscriber Service Card

Stable Amplitude Oscillator

A 1 cps to 100 kc stable-amplitude ultra-low distortion oscillator, featuring 0.01% amplitude stablity and 0.01% distortion, is available from Krohn-Hite Corp. Model 446 produces a pure sine wave that is continuously adjustable in frequency from 1 cps to 100 kc. Frequency calibration accuracy is within 1% from 1 cps to 10 kc. The unit is nearly free from "hum bounce" or line frequency beat — less than 0.05% — when operating near line frequency or hits harmonics.

Circle No. 231 on Subscriber Service Card

Cryogenic Thermometer

A completely integrated electronic cryogenic thermometer is available from Malaker Laboratories, Inc. The *Cryotherm* measures temperatures in the range of 0.3°K to 25°K. Measurements can be made readily without need for any special compensation and read directly on a calibrated scale to extreme accuracies.

Circle No. 232 on Subscriber Service Card

Shaft Encoder Translator

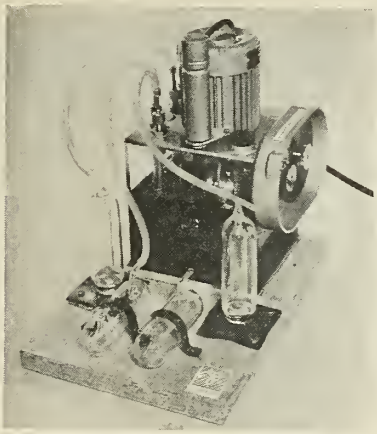
A shaft encoder translator designed especially for use in high-accuracy inductosyn systems has been developed by Harvey-Wells Electronics, Inc. The X116 is the final functional unit in a complex system containing four separate shaft position encoders. For each input angle—e.g., azimuth and elevation—there is a high-speed, high-resolution photo-electric encoder that converts the position of an inductosyn-driven secondary shaft into 13-bit binary gray code.

Every 180 degrees revolution of this secondary shaft corresponds to one degree of primary shaft revolution, which means that every two degrees of primary shaft revolution are quantitized into 8192 parts.

Circle No. 233 on Subscriber Service Card

Gas Mixing Pump

A gas mixing pump that provides various ratios of accurately measured gases for calibrating gas analyzing instruments over their entire range is being marketed by Instrumentation Associates, Inc.



The pump, which features an accuracy of ±0.05%, permits two or more gases to be combined in one mixture in in concentrations from 1 to 99%. As a result, it eliminates the necessity of storing many cylinders of various gas mixtures normally required when calibrating gas analyzing instruments.

Circle No. 234 on Subscriber Service Card

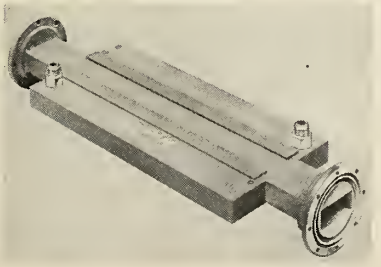
Filament Winding Machine

Narmco Research & Development Division of Telecomputing Corp. has developed a completely universal machine based on novel engineering principles and designed for filament-winding multi-shaped structural components. Designed to produce filament-wound structures of various sizes and configurations, the unit combines the operations of different filament-winding machines necessary for each basic shape. The unit's process parameters can be modified within a wide range, and shapes such as cylinders, sausages, spheres, ovaloids, cones, toruses and others can be wound within an envelope of 32 in. diameter and 90 in. length. Glass in single and/or multi-end configuration, wire or tapes may be wound, using wet or preimpregnated resin systems.

Circle No. 235 on Subscriber Service Card

Directional Couplers

Directional couplers being marketed by Bomac Laboratories, Inc., are available in three general configurations: cross guide coupling, sidewall coupling, and topwall coupling to meet the requirements of moderate cost, high-power handling capacity and high directivity, respectively. The units are available with customer specified coupling value, power handling capacities ranging from 70 to 2700 kw.



Circle No. 236 on Subscriber Service Card

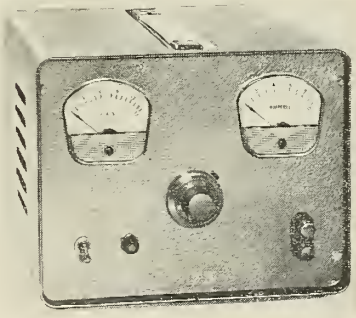
RFI Measuring Equipment

Model NM-30A, a frequency-selective, calibrated VHF microvoltmeter and special-purpose receiver covering the RF spectrum of 20 mc to 400 mc with a constant impulse bandwith of approximately 200 kc, is available from Stoddard Aircraft Radio Co., Inc. NM-30A features I-F output for panoramic display; single-knob tuning; a 4½-in. two-decade logarithmic meter scale to aid the operator in the investigation, analyzing, monitoring and measuring of conducted or radiated RF energy.

Circle No. 237 on Subscriber Service Card

DC Power Supplies

Dynex Industries is marketing two high-efficiency miniature solid-state power supply units. Model PS 120 provides low voltages for transistorized circuits, strain gages, etc., with an input of 105-135 vac, output is 0-10 vdc, current 0-1 amp. Regulation is 0.002%



for 10% line voltage change and 0-200mA load current. Model PS 150 applicable to filament supply and computers provides 6.3 vdc, 5 amp. with input of 105-135 vac. Regulation is 0.05% for ±10% line voltage change, 0-5 amp. load. Both units suppress line transients in less than 10 microseconds, and include pushbutton reset with automatic overload protection. Under complete short circuit, the internal regulating transistor in each dissipates less than one watt.

Circle No. 238 on Subscriber Service Card

Data Link Antenna

A dual-pattern UHF data link antenna, Type 35500, with a single unit configuration, is available from Transco Products, Inc. The unit has dual radiation pattern coverage, controlled by a self-contained coaxial switch in the power divider and phasing network.

COMING UP!

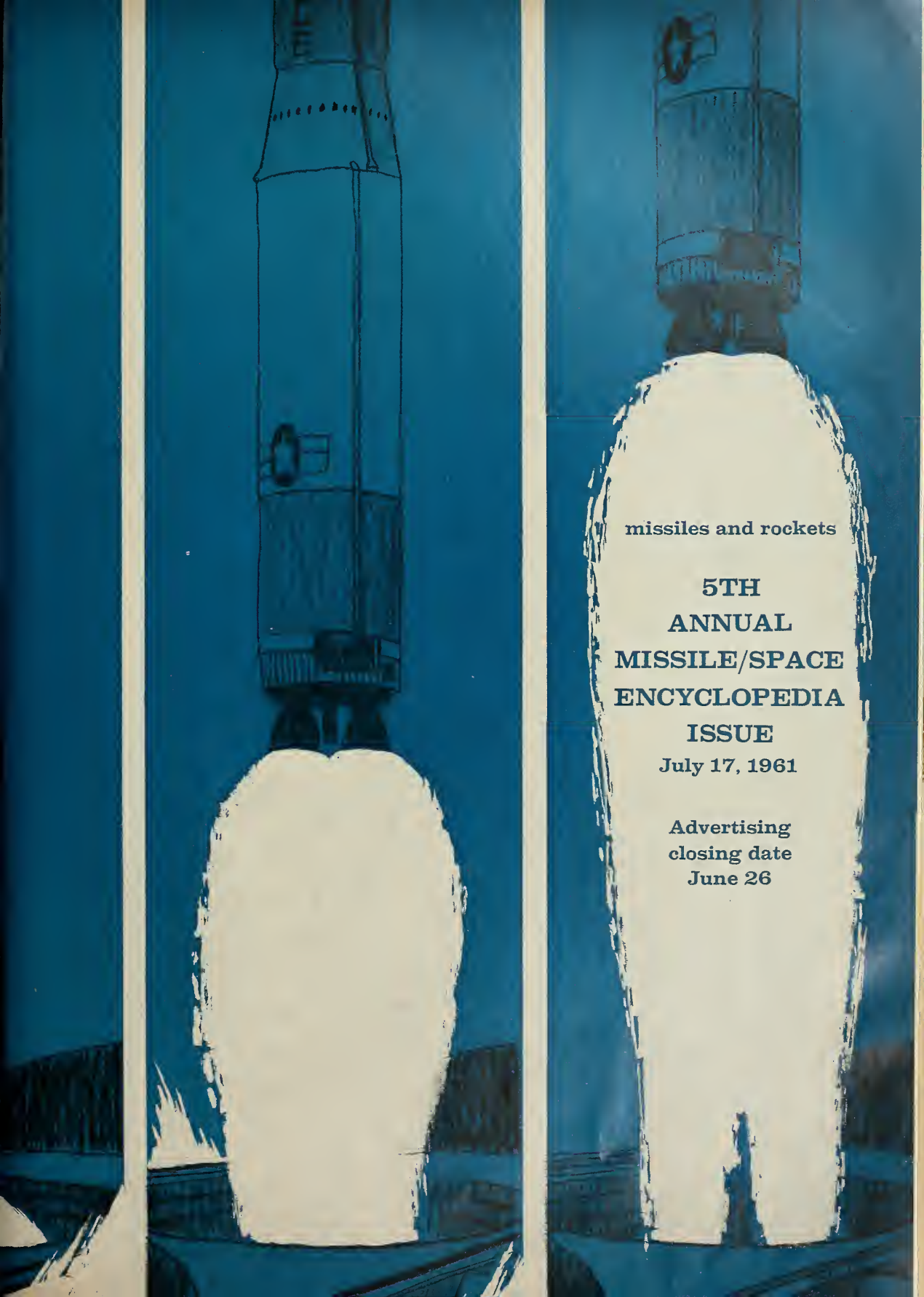
The only single source for a complete and comprehensive analysis of world missile/space systems, M/R's 1961 Missile/Space Encyclopedia will include diagrams and descriptions of all U. S. and foreign missiles and spacecraft.

The 5th annual issue of the Missile/Space Encyclopedia will be distributed to **MISSILES AND ROCKETS'** 32,500* paid subscribers—plus a bonus circulation of 7,500 for distribution to top military personnel and to U. S. service academies.

With a total distribution of more than 40,000, M/R's July 17 Missile/Space Encyclopedia issue will thus reach virtually all of the people who direct the activities of the missile/space industry, with the most complete coverage-in-depth of key buying and specifying influences.

*Subject to audit.





missiles and rockets

5TH ANNUAL MISSILE/SPACE ENCYCLOPEDIA ISSUE

July 17, 1961

Advertising closing date June 26



With the switch solenoid de-energized, the radiation pattern is essentially omni-directional in the azimuthal plane. In the energized position a cardioid-shaped radiation pattern occurs, producing a front-to-back ratio of −17 db or greater over the frequency range 225 to 400 MC. Polarization is vertical.

Circle No. 239 on Subscriber Service Card

Calibration Tester

A compact, secondary standard test instrument is being produced by Howell Instruments, Inc. Calibration Tester BH153 is a direct reading adjustable voltage source, simulating the DC electrical output of transducers with a setting accuracy of 0.05%. The BH153 is matched to the curve of any DC transducer in either direct or indirect terms of reference and simulates the outputs of thermocouples, pressure transducers, differential pressure transducers and strain gages in any desired scale units.

Circle No. 240 on Subscriber Service Card

Pocket Magnetometer

A pocket instrument that instantly measures the degree of residual magnetism in steel tools, parts and structures is available from R. B. Annis Co. In operation, a red spot on the bottom of the magnetometer case is placed near or against the object to be tested. The



pointer immediately deflects to a reading on the scale proportional to the magnetism in the part at that point. Magnetic polarity is indicated by the direction of pointer deflection on the center-zero, 20-0-20 scale.

Circle No. 241 on Subscriber Service Card

Frequency Comparators

The FC line of ultraprecision frequency and pulse rate comparators is available from Pioneer Magnetics, Inc. The unit is a completely static, self-contained precision detector which produces a DC voltage or current output whose polarity and magnitude depends in the difference in frequency between two input signals. Difference scale expansion ratios range up to as high as 10/1. Standard outputs available are 0-1 volt DC filtered, 0-5 volts DC filtered, 0-50 microamps filtered and 0-1 milliamps unfiltered.

Circle No. 242 on Subscriber Service Card

Compact Blower

A lightweight, compact, high-performance blower has been developed by Task Corp. The blower produces 277 ft.^{3}/min. at 5.91 in. of water in a 4.29 in. duct. Basic tooling permits variations to approximately 1.3 times original design flow rate.

Circle No. 243 on Subscriber Service Card

Phil-Trol Relays

Two micro-miniature relays are being marketed by the Phillips Control Co. Type 30-22 features "Spade" terminal header and is equipped with two-stud "L"-shaped mounting brackets. Type 30-23 features a 90° printed circuit header.

Circle No. 244 on Subscriber Service Card

Perforated Tape Handler

A high-speed uni-directional perforated tape handler is available from Digitronics Corp. Dykor Model 4544 handles 500 ft. of 5 to 8-level tape interchangeably, at speeds up to 500 characters per second. The unit is designed to function with the Dykor uni-directional Model 3500 photo-electric tape reader.

Circle No. 245 on Subscriber Service Card

Timing Terminal Unit

A compact timing terminal unit providing increased versatility and reliability for missile-satellite test ranges and tracking systems is available from Vitro Laboratories.

An all-transistor miniaturized unit, designated Model 90,000, it receives remotely generated timing signal inputs and provides local timing signal outputs for telemetry recording, data processing and ancillary equipment. It is applicable wherever timing accuracy and synchronization are of paramount importance.

The Model 90,000 provides 60-volt pluses at 200 ma with less than a 5-microsecond rise time into a 0.1 mfd capacitance, driving up to 20 lines in various combinations of requirements.

Circle No. 246 on Subscriber Service Card

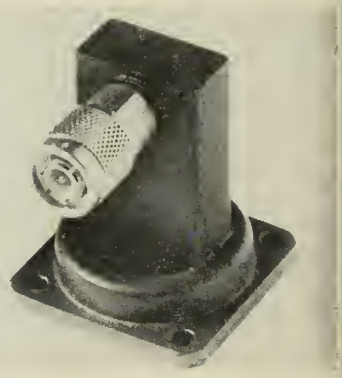
Be-Cu Strip

The Brush Beryllium Co. is marketing a mill heat-treated beryllium copper strip with tensile strength to 190,000 psi and formability exceeding all previous standards for this type of alloy product. Eliminating the need for customer heat treatment, these processes also thermally iron the material to a high degree of flatness and provide better uniformity throughout a coil and between lots.

Circle No. 247 on Subscriber Service Card

Waveguide Adapters

General RF Fittings, Inc. is marketing a series of waveguide adapters for use in the test laboratory, in the field or wherever a transition from coax to waveguide is needed. The units adapt coaxial cable to rigid waveguide through the use of either male or female TNC coaxial connectors and a short length of waveguide with a flange. Coaxial fit-



ting mates with standard TNC connectors and waveguide mates with standard X or C flanges. Waveguide adapters are also available TM to waveguide.

Circle No. 248 on Subscriber Service Card

Logarithmic Amplifiers

Instruments for Industry, Inc. has introduced a line of logarithmic-response IF amplifiers that provide a linear output change from a logarithmic input change, and a normal detected output. The amplifiers provide clear readings, logarithmic in spacing, at all levels between the maximum and minimum readings of a specific input range.

Circle No. 249 on Subscriber Service Card

D-C Function Generator

A DC adjustable function generator is available from Vernistat Division of the Perkin-Elmer Corp. The function generator, an adjustable nonlinear potentiometer, provides a rapid means of generating any desired nonlinear output with shaft rotation of an associated interpolating vernistat. The DC adjustable function generator can program and control any process or operation which is a function of shaft position or time.

Circle No. 250 on Subscriber Service Card

new literature

ASW REVISION—A current updating of the reorganization of the Navy's Bureau of Weapons Anti-Submarine functions has just been published by Defense Information, Inc. In conjunction with its already published ASW Directory, the firm has brought its current listings and organizational functions up to date with the BuWeps revision. This revision is presently available only as part of the complete Directory Service which covers the Navy's entire ASW effort.

Circle No. 200 on Subscriber Service Card

FLUTTER—A study of the phenomenon of flutter and its associated disturbances: wow and drift, is available from Amplifier Corp. of America. Basic theory is followed by a discussion of flutter measurement, causes, avoidances; and anti-flutter maintenance. Graphs and photographs illustrate the text.

Circle No. 201 on Subscriber Service Card

HARDFACING—A 44-page brochure has been issued by Air Reduction Sales Co. on hardfacing electrodes and wires. The wear protection provided on industrial and construction equipment by Airco hardfacing alloys is discussed in detail. A description of each electrode is presented along with application data. Over 100 specific equipment parts that benefit from hardfacing are listed in an extensive section, together with the type of wear to which each is subject and the alloy needed to protect it.

Circle No. 202 on Subscriber Service Card

VACUUM TECHNOLOGY—A catalog of high-vacuum technology and products has been published by the Vacuum Products Division, Varian Associates. The catalog contains technical descriptions of VacIon® pumps in sizes ranging from 0.2 liter/sec to 10,000 liter/sec; a brief explanation of the pump operating principle; and a list of VacSorb® pumps, power supplies, high-vacuum valves, control units, argon-stable Super VacIon® pumps, basic and special vacuum systems and accessories.

Circle No. 203 on Subscriber Service Card

contracts

NASA

$81,426—**Aro Cryo-Sonics, Inc.**, Los Angeles, for pump and vaporizer

$74,580—**Compudyne Corp.**, Hatboro, Pa., for services and materials for designing, furnishing and installing airstream oscillating system.

$42,000—**Space Electronics Corp.**, Glendale, Calif., from Jet Propulsion Laboratory of Calif. Institute of Technology, for development, fabrication and testing of frequency multiplier subassemblies.

$33,238—**King-Knight Co.**, San Francisco, for vacuum system alteration for hypervelocity ballistic range at Moffett Field.

$29,070—**B&F Instruments, Inc.**, Philadelphia, for recording system, strain gage for Lewis Research Center.

NAVY

$36,000,000—**General Electric's Heavy Military Electronics Department**, Syracuse, N.Y., for AN/SPS-30 long-range, height-finding radar for use on missile cruisers and carriers.

$1,016,267—**Raytheon Co.**, Lexington, Mass., for continued component development for the *Polaris* missile guidance system.

$521,249—**American Bosch Arma Corp., Tele-Dynamics Div.**, Philadelphia, for design, development, and production of underwater battery missile switching system.

$228,399—**Walker Electrical Co., Inc.**, Atlanta, for missile fire control switchboard for *Subroc* missile system.

$185,000—**Hoffman Electronics Corp.**, Los Angeles, from **Applied Physics Laboratory, Johns Hopkins Univ.**, for solar power supplies for a forthcoming series of *Transit* satellite experiments.

$160,000—**Collins Radio Co.**, Cedar Rapids, Iowa, for additional airborne ultrahigh frequency communication equipment.

$39,247—**Raytheon Co., Aero/Weapons Div.**, Waltham, Mass., for necessary services, labor and material to fabricate gyros.

ARMY

$7,875,000—**Fairchild Engine & Airplane Corp.**, Hagerstown, Md., for three long-endurance, multi-purpose drone systems AN/USD-5 (XE-2).

$556,782—**Sperry Rand Corp.**, Salt Lake City, Utah, for repair parts for the *Sergeant* guided missile system. (Three contracts.)

$246,298—**Electro-Optical Systems, Inc.**, Pasadena, Calif., for research and development program on base flow.

$225,184—**Nortronics**, Anaheim, Calif., for engineering services and repair parts for the *Hawk* missile system. (Two contracts.)

$113,552—**Nortronics**, Anaheim, for wing assembly for guided missiles.

$72,474—**Western Electric Co.**, New York City, for *Nike* replenishment spare parts.

$64,000—**Adler Construction Co.**, Hialeah, Fla., for addition to the SAGE structure at Richmond NAS, Dade County, Fla.

$37,054—**Landers, Frary and Clark**, New Britain, Conn., for radiation monitor system with auxiliary equipment for *Titan II* missile launch facilities.

$36,618—**Western Electric Co.**, New York City, for installation of modification kits for *Nike* missile system.

$32,330—**The Martin Co.**, Orlando, Fla., for finalization of engineering orders for the *Lacrosse* missile.

$32,606—**Douglas Aircraft Co.**, Santa Monica, Calif., for *Nike* replenishment spare parts.

$30,649—**Douglas Aircraft Co.**, Santa Monica, Calif., for low-bed trailer for guided missile.

$26,288—**Delta Electric Construction Co., Inc.**, San Antonio, Tex., for data link facilities and improvements for *Nike-Hercules* facilities, Dyess AFB Defense Area.

AIR FORCE

Electro-Mechanical Research, Inc., Sarasota, Fla., multimillion-dollar contract from **Boeing Co.** for development of the test instrumentation subsystem for the *Dyna-Soar* manned space glider.

$10,000,000—**General Electric's Missile and Space Vehicle Dept.**, Philadelphia, for development and procurement of 47 target missiles for *Nike-Zeus*.

$3,226,000—**Communication and Data Systems Div. of Collins Radio Co.**, Dallas, from **International Electric Corp.**, Paramus, N.J., for data transmission equipment for use in system to be installed for the Strategic Air Command.

$2,800,000—**Kollsman Instrument Corp.**, New York City, for celestial guidance ground support equipment.

$2,000,000—**Armour Research Foundation of Illinois Institute of Technology**, Chicago, for examination of all military electronic devices for possible mutual interference.

$841,500—**Motorola's Semiconductor Products Division**, Phoenix, Ariz., for research on new methods of encapsulating semiconductor devices.

$600,000—**California Eastern Aviation, Inc.**, Washington, D.C., for airborne countermeasure device (ALE-20) for the B-52H *Skybolt* missile bomber.

$450,000—**United Control Corp.**, Seattle, from **Boeing Co.**, for temperature control equipment for use in connection with silo-based *Minuteman* missiles.

$105,600—**Aerojet-General Corp.**, Azusa, Calif., for thrust chamber assembly and injector.

$103,060—**Dunn Engineering Corp.**, Cambridge, Mass., for equatorial turntable.

$95,585—**Space Technology Laboratories, Inc.**, Los Angeles, from Rome Air Development Center, for study of the use of an electronic device for generating electromagnetic radiation; $66,000 from Rome Air Materiel Area, for ground readout equipment units.

$95,236—**Rescon Electronics Corp.**, Waltham, Mass., for design, fabrication, installation and testing of a solid-state radar data processor.

$93,560—**Hughes Research Laboratories, Div. of Hughes Aircraft Co.**, Malibu, Calif., for services and materials for one year leading to development and construction of a solid-state maser amplifier and closed system refrigerator.

$65,502—**Bendix Corp.**, Baltimore, for design and fabrication of rocketsonde as a payload for a rocket sounding system.

$65,000—**Waltham Laboratories of Sylvania Electronic Systems**, from Rome Air Development Center, for development of mathematical procedures for reliability prediction of future electronics systems and system components.

$59,050—**Electro-Optical Systems, Inc.**, Pasadena, Calif., from **Office of Scientific Research**, for plasma propulsion research using electrically exploding wires or thin metallic films to generate the plasmas.

$45,000—**Goodyear Tire & Rubber Co., Akron, Ohio**, from the **Boeing Co.**, for design and development of the main landing gear for the *Dyna-Soar*.


SNAPP


TORIAN


COLLINSWORTH


BROWN


GALE

Vice Admiral William F. Raborn, Jr.: Director of Special Projects, U.S. Navy, will be presented with the Robert J. Collier Trophy for directing the creation of the *Polaris* missile weapon system during 1960. The trophy is given annually by the National Aeronautic Association under the sponsorship of *LOOK* magazine "for the greatest achievement in aeronautics or astronautics in America, with respect to improving the performance, efficiency or safety of air or space vehicles, the value of which has been thoroughly demonstrated by actual use during the preceding year."

Frederick J. Seufert: A director and former executive vice president and director of engineering, elected president of U.S. Science Corp., Los Angeles. **H. V. Brantly:** Former director of marketing, promoted to vice president.

Dr. William R. Laidlaw: Appointed manager of the advanced systems department at North American Aviation's Space and Information Systems Division, Downey, Calif., where he will be responsible for advanced aerospace system studies in both military and non-military categories.

Roy B. Snapp: Appointed divisional vice president of American Machine & Foundry Company in charge of its Washington office. Prior to joining AMF, Snapp was secretary of the U.S. Atomic Energy Commission.

H. Edward Rice: Named vice president-operations of Philco's Government and Industrial Group, Philadelphia. Prior to joining Philco, Rice was manager of manufacturing for GE's Light Military Electronics Department, Utica, N.Y.

Harry A. Sosnoski: Appointed manager, planning for defense electronics products, Radio Corporation of America, New York City. Previously he was director of product development for the Energy Division, Olin Mathieson Chemical Corp.

Henry W. Vogtmann: Promoted to senior test engineer for systems and components, **T. S. Torian** to director of contracts and planning, for the Bendix Corp.'s Mishawaka Division in Indiana.

Leslie J. Cook: Former manager of West Coast operations for the Perkin-Elmer Corp., joins Electro-Optical Systems, Inc. as manager of the Fluid Physics Division, Pasadena, Calif.

C. L. Burton: Promoted to development manager for aerospace and military equipment for the Aluminum Company of America, Cleveland.

Even T. Collinsworth, Jr.: Elected president and chief administrative officer of Fansteel Metallurgical Corp., North Chicago, succeeding **Dr. Frank H. Driggs,** who was elected chairman of the board.

Dr. William H. Clohessy: Prominent physicist, appointed director of research in the Advanced Program Department in a major expansion of The Martin Company's space research and development program in Denver. Dr. Cohessy's team will be responsible for research and theoretical studies anticipating the requirements of space and weapon systems of the future.

Joseph Butensky: Appointed assistant to director, Defense Systems Department, Servo Corp., Hicksville, L.I., N.Y., serving as coordinator between field personnel and Hicksville-based engineering and manufacturing divisions. **Frank J. Kocsis** transferred to this department to serve as New York area field engineer and infrared specialist.

James P. Brown: Former vice president and general manager of Astronics Division, promoted to vice president and corporate director of marketing of Lear, Inc., Santa Monica, Calif.

Dr. I. H. Swift: Appointed director of Information Systems Laboratory at North American Aviation's Space and Information Systems Division, Downey, Calif. Prior to joining NAA, Dr. Swift was assistant director of Hughes Research Center's infrared laboratory.

Dr. F. E. Brooks, Jr.: Former director of research and development, elevated to senior scientist for Temco Electronics Division of Ling-Temco Electronics, Inc., Dallas. **William A. Tweedie** has been promoted to vice president and general manager of Ling Electronics Division.

Robert F. Ward and **Joseph B. Heimann:** Elected vice president-precision components group and avionics group, respectively, of the Kearfott Division of General Precision, Inc. and **Thomas J. Thomas,** former general manager, computer and control, promoted to vice president in charge of computer and controls and power equipment.

A. R. Gale: Vice president of Ampex Corp., elected a director of Controls Company of America, Chicago.

Dr. Luke Harvey Poe, Jr.: Former director of the Physics and Chemistry Laboratory, St. John's College, named assistant to the president of Aerojet-General Corp., Azusa, Calif.

Allen S. Dunbar: Named manager of space flight activities at the Maryland Division of Litton Systems, Inc. Dunbar will direct scientists and technicians who are engaged in reducing data obtained from satellite and space probe programs. Before joining Litton Systems, he was chief of electronics research for Convair, San Diego.

Dr. Clayton F. Black: Joins the systems research staff of The Bissett-Berman Corp., Los Angeles, with the missile defense and related space program activities of the corporation his principal interest. Formerly Dr. Black was active in Loral Electronics programs for development of ballistic missile space concepts and space system studies.

Richard P. Gifford: Manager of the Communications Products Dept., General Electric Co., Lynchburg, Va., appointed a member of the Joint Technical Advisory Committee to fill a vacancy left by the recent death of **Dr. John V. L. Hogan.** JTAC is sponsored by EIA and IRE and is currently making a special study of frequency allocations problems in space communications for the FCC.

Communications

(Continued from page 39)

both common carrier frequencies). GE plans to use 10 relay satellites in conjunction with 19 ground stations. IT&T will soon begin moon-bounce communication experiments with England. It has recently received an FCC license for experimenting with passive relay satellites. The frequencies assigned to IT&T are 2299.5 MC., previously allocated by the ITU for space research, and 2120 MC. (until July 1, 1961 only), a common carrier frequency.

On March 1, 1961, the Radio Corporation of America (RCA) urged the Government not to give any one company a preferred position. It favored satellites owned and operated by a group of companies, and "open to full and independent access" for all international communications. In its brief, filed with the FCC, RCA disclosed that it was considering a joint venture with Lockheed Aircraft Corporation and General Telephone and Electronics Corporation to develop and operate a communication satellite system as a service to all carriers." According to its plans, an experimental satellite will be launched within a year. When the system becomes operational, "circuits will be made available to other communications common carriers for use in their business if they desire."

NASA has asked Congress for a total of $68.6 million—24 million during the current fiscal year and 44.6 million for next year—to develop communication satellites. According to NASA plans, about $50 million of this amount will be used to develop a commercially adaptable active system (Project *Relay*.)

The Department of Defense is spending some $50 million a year on communication satellites, and will soon be spending much more.

Nor are such developments confined to the United States. Eventually they are bound to involve every nation on earth.

At present, it is true, the United States appears to stand alone in this field of space technology. The Soviet Union has not made any known experiments.

Other advanced countries, however, are already planning programs for satellite relays. British interest is especially keen. In late 1960, a team of British experts visited Washington for talks about communication satellites.

According to a New York Times dispatch of December 29, 1960, "The House of Commons was recently told that astronomical profits would accrue to the American Telephone and Telegraph Company under a communications system using satellites. . . . Behind both the (British) Government program and the criticism of it by Tory backbenchers lies a desire to compete with the United States in world-wide communication systems based on satellites."

The government-owned telephone agencies of Great Britain, France and West Germany have expressed interest in establishing an international space communication system linking the United States and Europe.

Ten European nations have recently formed a "space club," tentatively known as the European Space Research Group. Member nations are Belgium, Denmark, France, Italy, the Netherlands, Norway, Spain, Sweden, Switzerland and the U.K. One of the first objectives of the Group is a communication satellite system.

Evidently the age of space communications is no longer a distant prospect. It has nearly arrived. When it comes, it will have the same kind of impact on our lives as the inventions of the telephone and the radio. ⁂

—when and where—

MAY

ARS National Telemetering Conference, Sheraton Towers Hotel, Chicago, May 22-24.

Fifth Global Communication Symposium (Globecom V) and National Telemetering Conference, sponsored by American Institute of Electrical Engineers, Institute of Radio Engineers, Institute of the Aerospace Science and Instrument Society of America, Sherman Hotel, Chicago, May 22-24.

Design Engineering Show, Cobo Hall, Detroit, May 22-25.

Society of Automotive Engineers, Military Ground Support Equipment Committe, Continental Hilton Hotel, Mexico City, Mexico, May 23-25.

Electronic Industries Association 37th Annual EIA Convention, Pick Congress Hotel, Chicago, May 24-26.

Operations Research Society of America, Ninth Annual Meeting, Sheraton-Blackstone Hotel, Chicago, May 25-26.

First National Conference on Peaceful Uses of Space, sponsored by National Aeronautics and Space Administration and the Tulsa Chamber of Commerce, Tulsa State Fairgrounds, Tulsa, Okla., May 26-27.

Chemical Institute of Canada, Forty-fourth Annual Meeting, Ottawa, Canada, May 29-31.

7th Annual Radar Symposium (SECRET), University of Michigan, Institute of Science and Technology, Ann Arbor, May 31-June 2.

JUNE

National Machine Tool Builders' Association, 59th Spring Meeting, Mayflower Hotel, Washington, D.C., June 1.

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editorial . . .

Lessons from the Labor Hearings

THE STORY of labor troubles which have delayed construction of U.S. missile and space bases is a sordid one. That story is written into the record of the Senate's Permanent Investigating Subcommittee. It should not be overlooked.

The figures are of such a magnitude there is danger they may be greeted as just another column of statistics. But take a careful look at them. The subcommittee was told that during the past 4½ years there were 327 strikes at 22 missile bases. Lost time from these totals 162,000 man-days of work.

Our missile and space programs are at least six months behind schedule as a result. Yet a prominent union official, C. J. Haggerty, president of the AFL-CIO Building Trades Department, tried to convince the McClellan subcommittee that strikes were a minor factor in base construction delays.

Testimony before the subcommittee indicates otherwise.

Without question, the concurrency concept of building missile bases with the missiles themselves still under development led to an unexpectedly large number of change orders, contributing to the lag. But this fact itself should have instilled an even greater sense of urgency in the program.

Instead, the picture drawn before the subcommittee was one of jurisdictional disputes, make-work practices, exorbitant wages and low productivity. As a taxpayer, you have been taken for an expensive ride by some of your fellow Americans. The story of the construction worker drawing a larger weekly salary than the Secretary of Defense already has been widely reported.

B. G. MacNabb, Convair's operations chief at Cape Canaveral, testified that production on construction jobs at the Cape was about 40% of the rate civilian industry would require.

Blame for this must be shared by the government officials and contractors who condoned the practices. Firmer management would have cut sharply into the delays and saved the nation literally millions of dollars.

The question has been raised whether the subcommittee is flogging a dead horse, since most of the damage to the *Atlas* and *Titan* programs has been done.

Work of the McClellan group already has had several beneficial effects, however. Once the investigation began, labor troubles at the Cape dropped off sharply. With the subcommittee in session, contractors at Canaveral instituted several procedures for greater efficiency which probably would have led to walkouts earlier.

"The best thing the subcommittee could do for us would be to stay permanently in session on this problem," commented one program manager.

DISCLOSURES before the subcommittee also needled the Department of Defense into action. The practice of standing aloof from labor problems, certainly an absurd posture in programs of such urgency, was reversed. The Air Force was ordered to halt any wasteful labor-management practices in base construction. President Kennedy and Labor Secretary Goldberg also have indicated they plan to act.

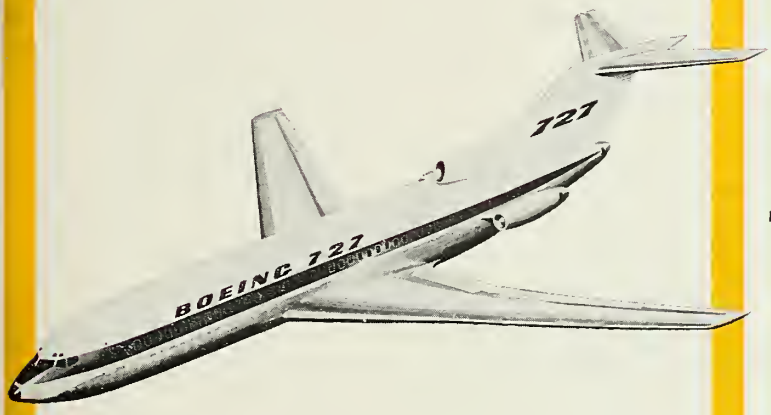
With this backing, contractors can deal more firmly with the unions.

Testimony in the hearings revealed a number of expensive labor practices which already are beginning to gnaw at the *Minuteman* program, particularly in the Montana area. It is perhaps too late to do much for the *Atlas* and *Titan* programs, but the government should move promptly to keep labor costs on the new missile and space programs well in hand. A good place to start would be with a careful reading of the testimony presented on the Hill.

The good work of the McClellan subcommittee should not be wasted.

William J. Coughlin

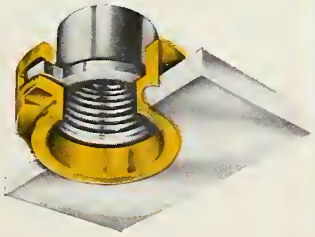
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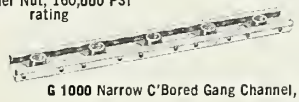
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Space-Age Project "HEAT FOIL"

A CHEMICAL EXPEDITION...











...searching for plastics materials that can "take" temperatures of 20,000° F. plus

Monsanto has developed high-heat-resistant resins for laminates that remain intact for upwards of 2-3 minutes at temperatures as high as 20,000° F.; that maintain integrity for 200 hours at 600° F. Under evaluation are plastics laminates that hold promise for rocket nose cones, nozzles, and other components exposed to high heat.

By applying basic knowledge of polymer chemistry to the problem of service life under heat, Monsanto is making new breakthroughs on the problem of high-heat resistance with plastics. One of the most promising plastics now being evaluated is a silane-modified phenol-formaldehyde resin which makes laminates and moldings that retain integrity after hundreds of hours of exposure to temperatures of 500-600° F. Still other polymers under development hold promise of broadening temperature resistance for increasing lengths of time.

MOLECULAR DISSOCIATION SETS UP COOLING ACTION

Some resins under study form a char layer which insulates the interior and reradiates a large portion of frictional energy. Plastics laminates made from such resins provide insulating walls for interior surfaces or areas.

HEAT RESISTANCE—PLUS STRENGTH AND LIGHT WEIGHT

As in many other fields, laboratory tests for space-vehicle science are hard to correlate with actual field performance. In standard Oxyacetylene Tests and Stabilized-Arc Tests, heat-resistant plastics laminates show adequate retention of structural integrity under high-heat stress.

Like other, more common reinforced plastics, the new heat-resistant laminates have exceptional mechanical strength. The following table indicates some of the mechanical properties obtained with a ⅛" section of a laminate made with a Monsanto silane-modified phenol-formaldehyde resin.

Property	Results	MIL-R-9299 Specifications
Flexural Flatwise		
Standard Condition 75° F.	73,800 psi	50,000
30-Day Water Immersion	73,400 psi	45,000
½ hr. @ 500° F.	62,900 psi	40,000
100 hrs. @ 500° F.	57,600 psi	20,000
200 hrs. @ 600° F.	22,600 psi	No Spec.
Modulus of Elasticity		
Standard Condition 75° F.	3.72×10^6	3.0×10^6
30-Day Water Immersion	3.65×10^6	3.65×10^6
100 hrs. @ 500° F.	3.28×10^6	2.5×10^6
200 hrs. @ 600° F.	1.48×10^6	No Spec.
Tensile Strength		
Standard Condition 75° F.	45,600 psi	40,000
30-Day Water Immersion	45,400 psi	38,000
100 hrs. @ 600° F.	23,100 psi	No Spec.
Edgewise Compression		
Standard Condition 75° F.	50,800 psi	35,000
30-Day Water Immersion	42,000 psi	30,000
100 hrs. @ 600° F.	8,240 psi	No Spec.
Barcol Hardness	76	55
Flammability	Self-extinguishing	1.0 max.

Mechanical Properties of Resinox® SC-1013 Laminates. (⅛" section; E.C.D. 225-181 gloss cloth; 12 ply; 200-psi pressure cured 1 hr. at 250° F.; post cured in gradients of 50° F./24 hrs. each to 500° F.; resin content 29%) (Tests carried out as specified by MIL-R-9299)

COMMERCIAL PROMISE, TOO!

In addition to the properties described, the plastics laminates created for high-heat resistance are practically immune to fuels, oils, and solvents.

(Please turn page)

OUTSTANDING ELECTRICAL PROPERTIES

Heat-resistant plastics laminates have also shown outstanding performance in electronic applications wherever frequent cycles of heat and cold are a problem. While maintaining mechanical strength, plastics laminates (as described) showed no degradation of dielectric constant or loss tangent. The following table shows results on a typical panel after various numbers of cycles of heating for one hour at 550° F., then cooling ¼ hour to room temperature.

ELECTRICAL PROPERTIES AFTER CYCLING
(Approximately 9 KMC Resonant Cavity)

	Room-Temperature Electrical Properties	
No. of Cycles (1 hr. at 550° F.; ¼ hr. to 77° F.)	Dielectric Constant	Loss Tangent
0	4.8007	0.0217
100	4.7289	0.0218
150	4.7347	0.0218
200	4.7218	0.0214

OPTIMUM PARTS PERFORMANCE

In fabricating parts for optimum performance under high-heat conditions—fibrous glass, asbestos, or nylon is impregnated with resin, is molded, filament-wound or laminated by any of several methods, then cured.



THE CONTINUING SEARCH

Project "Heat Foil" is a continuing study of resins for high-heat resistance and of resins whose energy of dissociation makes them outstanding for high-temperature applications. This search will continue to develop materials that will help answer the high-heat requirements of a space age, in defense and industry. MONSANTO CHEMICAL COMPANY, Department MR-5, C Building, St. Louis 66, Missouri.

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THE COVER

M/R artist's conception symbolizes U.S. effort to get manned spacecraft to the moon and planets. The effort is plagued by problems. See special report starting on p. 32.



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† U.S. Reg. Pdg.

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Further on MR-3 Publicity

To the Editor:

I think the views you have expressed in the May 8 and May 15 editorials on the Man-in-Space program are the feelings of many who are connected with the missile industry, not only the Man-in-Space Program.

The publicity that has been given to the Man-in-Space program was vividly brought to my attention recently when I visited my 3-year-old nephew. His version of the program is as follows:

Silent night, Holy night,
All is calm, All is bright,
Shepard's in Space.

Charley Mathay
Development Engineer
Tapco Group
Thompson Ramo Wooldridge Inc.
Cleveland

To the Editor:

I am appalled at your editorial, which too neatly subscribes to our Administration's program toward the U.S. citizen's ignorance of space.

The attitudes shown in M/R, May 8, are:

Page	Article	M/R	Admin.
7	"No News . . ."	Shout	Shut-up
54	"Editorial"	Shut-up	Shout

True, a problem is evident in space public relations; the U.S. press, radio, and television did "circus-up" the event in their everyday grab for an audience.

But please remember: 1) we are in a public opinion space race, 2) the free public feels that *Mercury* is their honor and prestige, 3) the per capita price of Freedom 7 ($2.25) *is* the ticket price of an extravaganza movie, 4) the *Redstone* vehicle is quite reliable, 5) McDonnell's fine staff have been paid to *over-engineer* the capsule, 6) the only capsules "lost" had *no* escape system, though the sensors and relays activated wildly to abort, and 7) by publicizing all attempts, we display to the free world and neutral nations our active truthfulness and honesty in the most evident manner—as we have also done with *Vanguard,* the U-2, and Cuba.

I wholeheartedly agree that our news media need many lessons in tasteful reporting and that some of the *Mercury* coverage was "nauseous" and "inane." But no matter how appealing the Soviet "news-as-history" approach may be; for any "space birthday party" in the U.S., the cake must be cut and served *at* the party—not packaged and mailed the next day as a feast for fungi and insects.

Whether our next attempt is a fiasco, partial success, or complete achievement, let us not play "guess-which-hand-the-marble-is-in."

Jamison D. Welsh
Co-op Student, Space Systems Intelligence
Astronautics Div.
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Dallas

To the Editor:

When I finished my 37 months as Director of Guided Missiles in 1953, I decided that I would refrain from any public comment in the field, because once you are out of direct contact with an endeavor, you are not so well equipped to be either a critic or an appraiser.

However, on reading the May 15 M/R, I am impelled to compliment you on the splendid editorial. I have also read, with considerable interest, the *Redstone* article by James Baar.

I think there is one thing that is usually overlooked in comparing the *Redstone* to the *V-2*. The *Redstone* had a stable platform that made it possible to employ a much more reliable guidance than any of the *V-2's* had. It also had the benefit of more years of development on propulsion. I quite well remember the days in early 1951, when Wernher von Braun made a splendid presentation of his plans for the *Redstone*.

We gave his ideas a very thorough going over. It was a very small meeting; I had five members of my staff with me. As we drew near the close of the meeting General Terhune of the Air Force (then Colonel Terhune) passed a note to me which said, "Mr. Keller, you and Wernher von Braun have just given birth to a missile!"

It is interesting to analyze the tremendous progress that has been made these last ten years. The propulsion motor is developing at least twice the thrust that it had in 1951, and the special work of the atomic energy boys has produced a warhead of equal destruction of about one quarter or less of the weight that we had to figure on in 1951. Both of these things have greatly increased the range of the *Redstone*.

I am just writing this in the interest of fact and clarity, and hope it will be of interest.

K. T. Keller
Detroit

Dean Space Drive

To the Editor:

The article by Charles D. LaFond on the Dean System Space Drive (M/R, May 1, p. 24) was particularly interesting to me because several years ago I had an exciting "ride" in Long Island, N.Y., on a similar device being developed by Assen Jordanoff. Jordanoff's centrifugal force converter was beyond the status of just proving a principle. I helped him measure output vs. input to get the efficiency. The 500-lb. man-carrying vehicle attained a speed of ⅓ mph. The sheer novelty of the concept intrigued me then and still does.

Alfred Africano
Rendondo Beach, Calif.

To the Editor:

Re your article on Dean's Space Drive, must have Dean's address immediately. Your cooperation deeply appreciated.

Over 20 years ago I devised, on paper, an anti-gravity method based on displaced inertial masses, and was discouraged by financial conditions from experimenting with it. However, I did take it to the chief of engineering and design at Douglas Aircraft, where I was then employed, and to the head of the Physics Department at U.C.L.A., where I had recently obtained my Master's Degree.

The peculiar results, in both cases, were exactly these:

1. Initially—derision.

2. After some investigation, the independent conclusion of both men was as follows:

Seems impractical, but no way of disproving it. There is *no mathematical basis* for measuring this new principle. Therefore, it must be proved experimentally.

My method seems to provide the missing link for Dean's system, in that it cuts out a great deal of gearing and throws many of the mechanical processes into the realm of electronics, thereby saving space and weight. A hint of its nature is in the name I have given it: the planetary rotor (in which inertial masses orbit *free,* like a true planetary system). Remember, Nature made all the discoveries before we did. I am only copying Nature.

My object with Dean: I have given up on the financial end. My idea may be worthless, or it may be a bottleneck-buster. I am willing to place myself completely at Dean's mercy, as I feel he will get somewhere. What he wants to do about my contribution, if it's worth anything, is up to him. However, I'd like to give him my concept.

I am an engineering writer in the missile field.

S. J. Byrne
B.A., M.A.
Van Nuys, Calif.

For the benefit of Mr. Byrne, and others who may be interested, the address is:

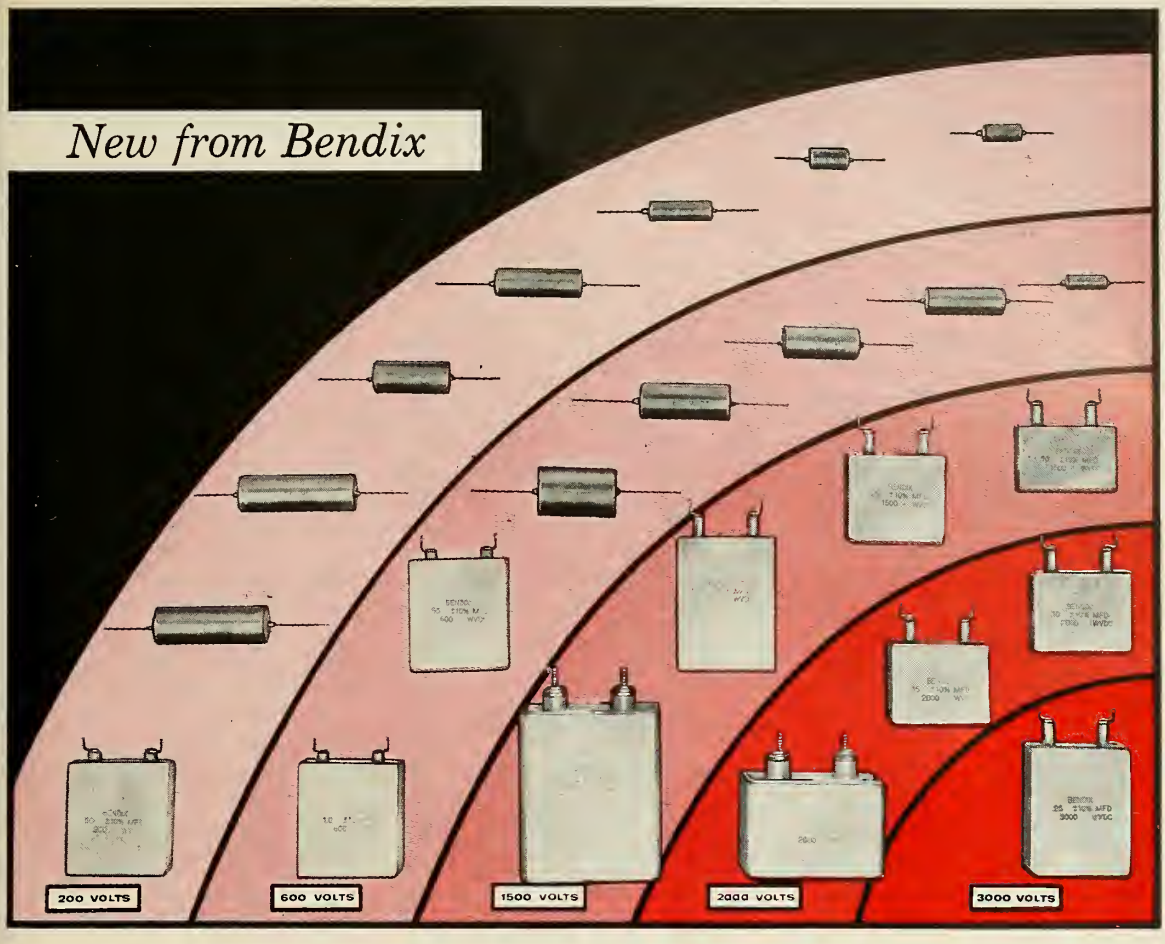
Mr. Norman L. Dean
3601 Wisconsin Ave., NW
Washington, D.C.

More on Wire & Cable

To the Editor:

In your March 27 issue was a "Study in Near-Chaos" by Mr. Hal Gettings together with a Special Report by Mr. Edward W. MacLaren regarding wire and cable problems in the missile industry. We generally agree with most of the statements made in these articles, but we are highly concerned about the accuracy of Mr. MacLaren's statement regarding a $3 million cost per site of missile ground-cable systems—and "in some instances as much as $10 million."

Several years ago, as one of the Composition F approved sources for MIL-C-13777 cable, we had made a market study of the requirements for this cable. Initially this study produced essentially the same figure quoted by Mr. MacLaren. However, believing this to be an exaggerated reporting, we made a more intensive survey. This re-evaluation of the market brought



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us to the conclusion (which I think is shared by others in the cable business) that the original figure was highly inaccurate, and our own plans were made on what we felt to be a more realistic basis.

We would, however, be interested in knowing the basis for Mr. MacLaren's estimate of the scope of this market, and we would certainly appreciate any information you can give us on this subject.

Charles R. Riordan
General Sales Manager
William Brand-Rex Division
American Enka Corporation
Concord, Mass.

To the Editor:

The statement in the 7th paragraph of the article entitled "Standardization 'Engineering' Is an Urgently Needed Development" is overly generalized and grossly misleading in that there is an implication that from $3-10 million of ground *missile cable* is used for each missile site. Clarification of the statement by the author is requested and considered necessary.

The electrical system of a missile site utilizes wire and cable types of three broad categories, namely:

A. Wire and cable for light, heat, power, air conditioning, and control wiring for "brick and mortar" silo, and for housing.

B. Telephone and data transmission cables for inter-site and intra-site communications.

C. *Missile wire and cable* directly associated with the missile installation site to provide power and circuits for monitoring and control of the missile proper.

The cost estimate of $3-10 million per site is not plausible when applied as a per-site cost of *ground missile* cable (Category C cable).

A "missile site," depending on definition, can consist of one isolated missile firing site or "hole," or a group of sites forming a complex or a group of complexes. The cost of the missile ground system would obviously vary with "site" definition.

Additionally, sites can be of the operational or R&D type. For many reasons, the cable system for an R&D-type site may be of far greater complexity and require considerably more cable than an operational site.

Regardless of other factors which may have been considered by the author in arriving at the $3-10 million cost estimate, it would appear that the cost of cable per site and particularly the cost of missile cable (Category C as defined above) generally represents only a small percentage of the dollars quoted in the article. We believe that an editorial correction is in order.

T. DeLutis
Product Manager, Missile Cables
General Cable Corporation
New York

The author agrees that the "per site" cost definition as stated is open to misinterpretation. "Complex" might perhaps be a better word. In any case, accurate data on the missile W&C market is extremely difficult to determine (as most market researchers will quickly agree). Part of the problem is the lack of hard-and-fast functional discrimination between different types. Mr. MacLaren's figures included communication and support cable—which account for the bulk of installation costs. Also see the following letter.—Ed.

To the Editor:

In your wire and cable report was a statement that "It is no longer uncommon for a guided missile ground cable system to cost more than $3 million per site—in some cases as much as $10 million."

Since the scope of your special report was concerned mainly with missile and ground support cable (MIL-C-13777, etc.), it's quite possible that many of your readers may assume that the above dollar figures pertain to this type of cable. On this basis, and if the word "site" were used to mean a single missile pad, the *Minuteman* base at Malmstrom AFB, Mont., which will contain 150 missile sites, could be expected to have between $450 million and $1.5 billion in missile and GSE cable. Available figures would show this to be completely out of reason.

Actually, the amount of ground support cable per *Minuteman* missile is so far less than, for instance, an *Atlas-A* system that there is no comparison.

There is confusion in the Industry on missile terminology (squadron, base, complex, site, etc.) and the same words are even used differently from missile to missile. In addition, there is confusion about the various types of cables used. A given *Titan* base, for example, uses Power Cable, Communication Cable and Ground Support Cable, among others. The term "missile cable" is commonly used to denote the latter. It is often erroneously used to cover practically any type of wire and cable used by the Missile Industry, and this is where the confusion starts.

Perhaps your magazine could help to clarify the situation.

Bruce Van Wagner
Marketing Manager
Anaconda Wire and Cable
New York

Administrative Awareness

To the Editor:

Your March 6 editorial ("Let's Not Hang an Untried Man") was vague, but I could see your point clearly. The practice of placing administrative department heads in highly technical fields is widely practical and wise. The Air Force is probably the initiator of this, with its retraining program. President Kennedy's move was brilliant; and if you look a little more closely, all of his Cabinet is assigned on the basis of proven administrative awareness. Definitely, the choice was made to avoid duplication and waste of research and money. This, I believe, is why the slot was filled by Mr. Webb.

I can agree that the practice can always be discussed, with many pros and cons on both sides; but—speaking bluntly—with 40 to 100 missile programs advancing torridly, it was more a matter of need than of choice.

I am no relation to Mr. Webb.

Bernard J. Webb
926th ACWRON Box 143
Baffin Island, Canada

Airborne DC Amplifier

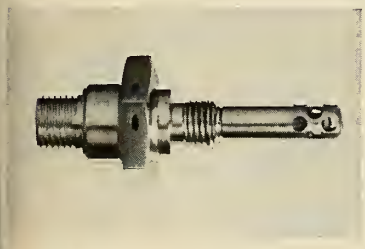


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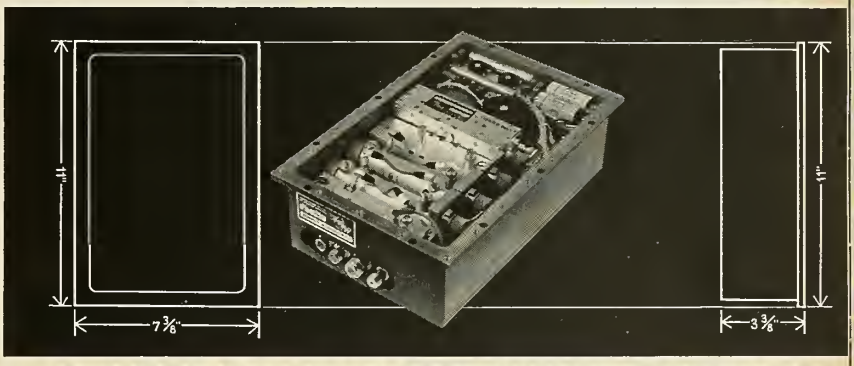


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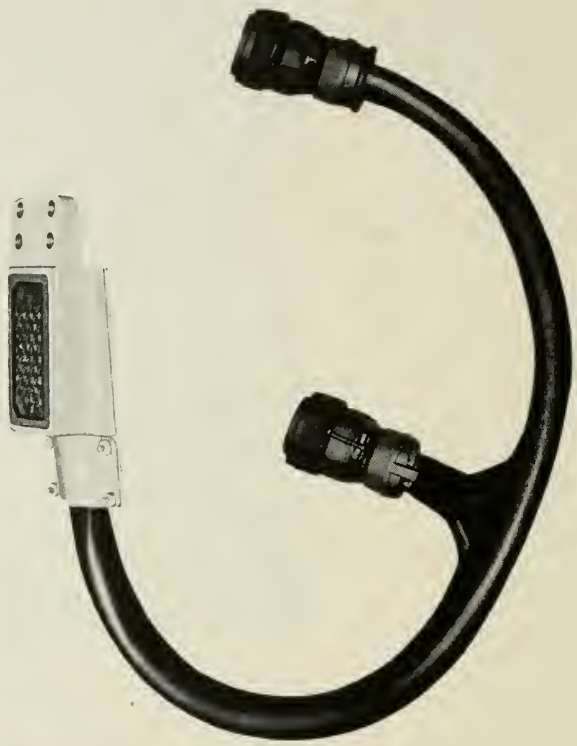












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The Countdown

WASHINGTON

Mobile Minuteman—Stretchout to Where?

All planned further R&D work on a mobile *Minuteman* in FY '62 will be financed out of funds salvaged from the $110 million set aside for developing the system in FY '61. This means tests with two or three railroad cars nearing completion—not five as originally planned. However, there is no Administration commitment that the mobile system ever will be deployed.

Fixed Minuteman—Buildup to What?

President Kennedy has about six months to decide whether to order a great increase in the total size of the hardened *Minuteman* force. About Dec. 1 is the deadline for taking full advantage of $36 million the Administration has requested to double *Minuteman* production capacity. After that, the value of the extra production capacity will begin to decline. So far the Administration has not increased the total planned *Minuteman* force, only accelerated deployment.

Abe Lincoln Launches Five of an Afternoon

The nuclear-powered submarine Abraham Lincoln, operating under DOD-imposed secrecy, is understood to have launched five operational *Polarises* down the Atlantic Missile Range in one afternoon earlier this month. She is understood to have sailed with a full load of 16. According to a Cape report, holds prevented the planned launching of more birds the same day. But the report is unconfirmed.

Gen. White's Druthers

The three top items on the Air Force suggestion list for restoration to the FY '62 budget are: More R&D for B-70 ($138 million); deployment of two more *Titan II* squadrons (about $100 million); more R&D for mobile *Minuteman*. Under the revised FY '62 budget, the Air Force says, the mobile *Minuteman* program is slipping about two years or more.

MA-3 Repeat Slips

NASA and Convair are still attempting to discover the cause of last month's *Mercury Atlas-3* failure to orbit an unmanned capsule. Hence, no date has been set for a repeat.

INDUSTRY

Thor: Shot in the Arm

Production of *Thors* by Douglas Aircraft is being extended through June 1962 by an Air Force order for 22 *DM-21* models to be used in space programs. The *DM-21* has a shorter, lighter airframe and develops 165,000 lbs. thrust. Douglas, in a bid for more space work, also is proposing to cluster three *Little Joes* (50,000 lbs. thrust each) at the base of *Thor* to increase total boost thrust to 315,000 lbs.

R&D Intelligence

AT&T is understood to be asking NASA for permission to buy a *Thor-Delta* to use in launching its first R&D commercial communications satellite. . . . Aerojet-General is set to fire a 100-in. segmented solid engine in an effort to hit 1 million lbs. thrust. . . . Mystery surrounds future plans for the *Titan* Silo Launch Test Facility at Vandenberg AFB. Since the first shot May 3 with a *Titan I*, the silo has been partially stripped and no announcements have been forthcoming on launching *Titan II's* or other vehicles from it.

On the Static Test Pad

"By the book" evaluation of both stages of *Titan I* will begin at Edwards AFB Rocket Test Agency following some stand modifications. . . . *Centaur* firings will start there within a few weeks.

Front Offices

Dr. James B. Rea is moving from Hughes Aircraft Co. to vice president and general manager-technical of Northrop Corp.'s Radioplane Division. Move is reported to be the first in a mild reorganization of Radioplane, to be followed by recruiting in the high-level technical staff. . . . RCA is staging a recruitment campaign for electronic engineers to go to the South Pacific for high-powered radar and radio work—possibly for Project *Press*.

INTERNATIONAL

British BMEWS Slips Six Months

Labor disputes involving only 30 spidermen who install steelwork have put the operational date for the British BMEWS Station six months behind the original target date of late 1962. British officials are reported to have refused to crash the job to make up for lost time. They contend that this would increase cost and jeopardize accuracy. The British station on Fylingdales Moor in Yorkshire is the third and last of the BMEWS net.

Data on French Missiles Disclosed

Latest facts on two ONERA research rockets: *Antares* —a four-stage solid capable of Mach 8 re-entry. Six successful launchings completed in last few months. *Berenice* —an improved *Antares* capable of Mach 12 re-entry. First launchings scheduled before the end of the year.

First Indian Transistor Plant Readied

Facilities for India's first transistor plant are under construction at Poona. The new company—Semiconductors Private, Ltd.—is expected to be turning out transistors and diodes by late 1961. Raytheon owns a one-third interest. Participants with Raytheon are Indersen Mirchandani and Taru Lalvani, prominent Indian businessmen.

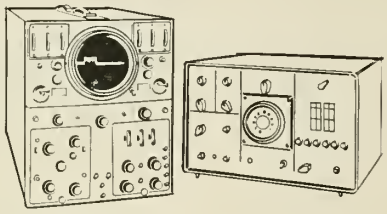
Overseas Pipeline

A public demonstration of the Vickers Armstrong *Vigilant* antitank missile is tentatively expected next month. . . . A major technical advance in underwater sound detection is reported to have been made at the NATO Research Center at Spezia, Italy. . . . The Japanese are launching a big drive to sell space research rockets in the world market. . . . Goonhilly Downs, in Cornwall, has been chosen as the site for an Anglo-American $1.5-million communications satellite ground station.

SPACE AGE PRODUCTS

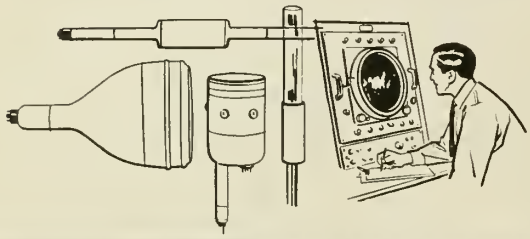
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INSTRUMENTATION FOR THE SPACE AGE



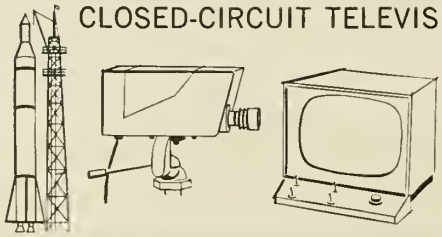
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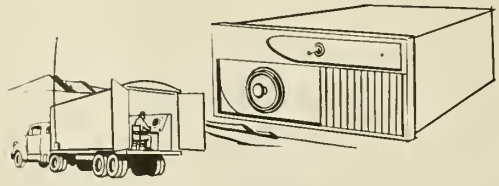
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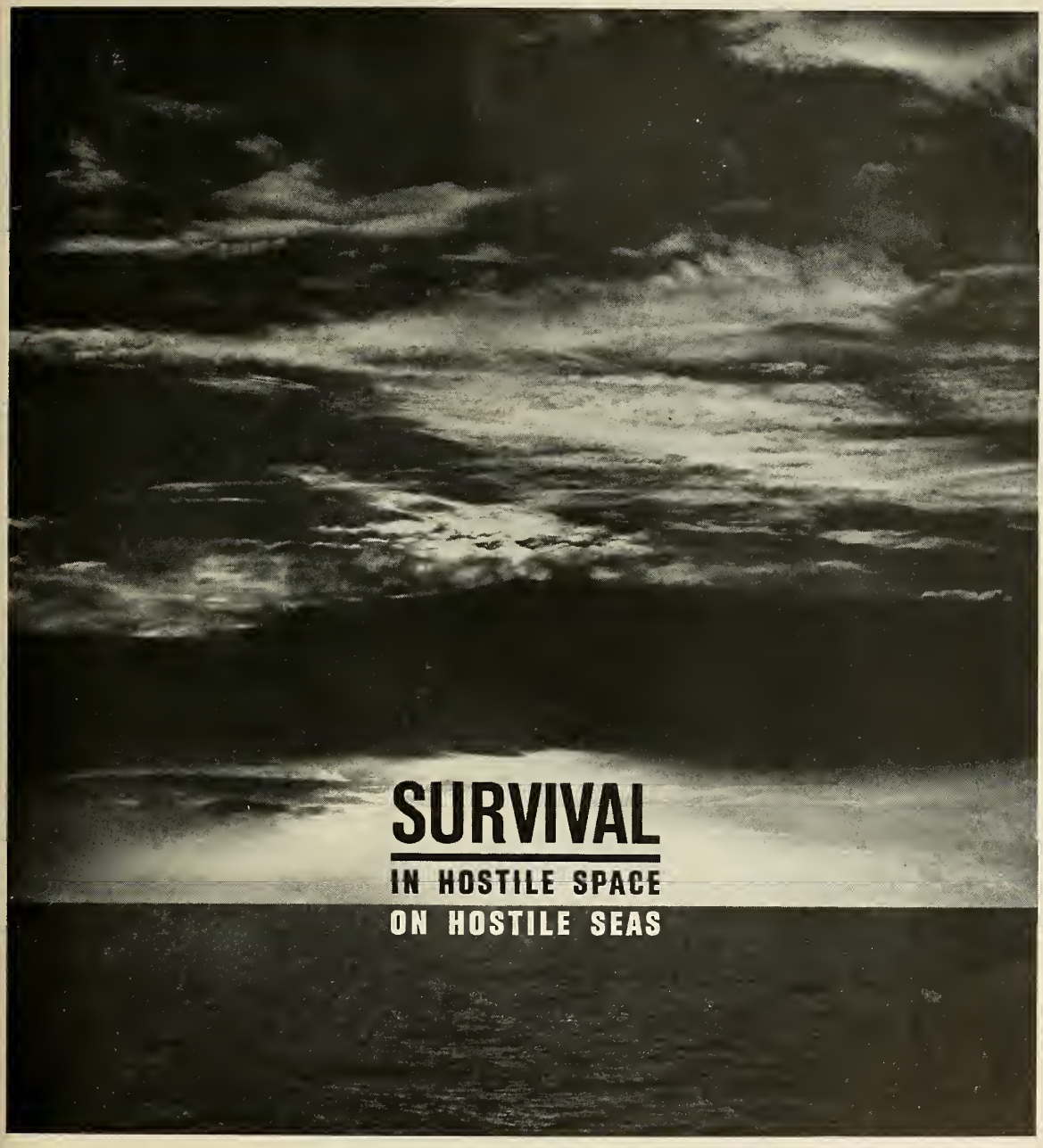
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Now—from a world at dubious peace—man launches himself into the hostile vastnesses of space. Among the strange new perils threotening his survival are radiation, lack of atmasphere, weightlessness. Working for 6 years with the Air Force Wright Air Development Division, International Latex Corporation has recently perfected the first space suit to combine "shirt sleeve" flexibility with protection. It weighs about 20 pounds, can be quickly put on by the weorer, allows pressurizotion to at least 5 psi.

This ILC space suit—actually a portable environmental system—is only one breakthrough in International Latex Corporation's continuing development program. In the life sciences we are now considering, among others, the essential problems of weightlessness and of thermal, particle ond electro-magnetic radiation—further steps in our constant effort to serve mankind by enabling him to survive in a hostile environment.

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Dyna-Soar Work Let

Four contracts totaling $9 million were let this week by Boeing Co. for components of *Dyna-Soar* integrated hydrogen power and cooling system.

Sundstrand Aviation-Denver has contracted to build an auxiliary power unit to drive the *Dyna-Soar* electrical generating system in flight.

Garrett Corp. won a major subcontract for R&D on *Dyna-Soar's* hydrogen cooling system, an important function in controlling the vehicle's environment.

Thompson Ramo Wooldridge Inc.'s Tapco Division will provide *Dyna-Soar's* reaction control power component.

A subcontract in excess of $1 million was awarded Westinghouse Electric for a 400-cycle, three-phase brushless generator and control unit for the winged vehicle.

RCA Gets Relay Contract

Radio Corp. of America will design and build the *Relay* active repeater communications satellite.

NASA's Goddard Space Flight Center, will negotiate a contract for about $3¼ million with RCA's Astro-Electronics Division to deliver four satellites—one prototype, two for flight and one spare.

The spacecraft, which will weigh between 85 and 100 lbs., are to be launched by *Delta* vehicles in 1962 from Cape Canaveral into orbits with perigee of about 1000 miles and apogee of about 3000 miles.

The British General Post Office and the French Center for Telecommunications Studies will provide ground stations in Europe for transmission of multi-channel telephone, telegraph and television signals.

RCA won out over seven other bidders or teams. The losers were Bell Telephone-Western Electric, International Telephone & Telegraph-General Electric, Collins Radio-Ford Aeronutronic, Philco, Bendix and Hughes Aircraft.

ABL Blast Probed

Authorities are still investigating a series of fires and explosions which rocked the Allegany Ballistics Laboratory's solid propellant division near Cumberland, Md., last week.

The blasts and fires caused nine deaths and injured six persons.

The initial explosion, which leveled one building, set off fires which in turn caused the explosion of another building some eight hours later. A third building was damaged.



Skybolt Slimmer, More Pointed

NEW SKYBOLT SHAPE is revealed at Armed Forces Day observances in Los Angeles. Elmer P. Wheaton (left), Douglas Vice President; Dr. Joseph V. Charyk (center), Undersecretary of the Air Force; and Donald W. Douglas, Jr., discuss details of the 1000-mile-range air-launched strategic missile.

Mercury Developments

At least two unmanned *Mercury Atlas* orbital launchings are planned this summer before an attempt is made at manned flight.

George M. Low, NASA chief of manned space flight, also told the Peaceful Uses of Space Conference, "if all goes well, the first manned orbital flight will be made before the end of 1961."

Meanwhile, other NASA sources reported that Astronaut Alan Shepard has recommended three minor changes for the next manned *Redstone* flight, which will probably take place in July.

Shepard suggested that the pressure gauge of the pressure suit, now on the astronaut's left wrist, be moved so that it will be more visible, that the astronaut be given more time for observation and that the time spent in the capsule atop the gantry be reduced.

Shepard on May 5 entered the *MR-3* capsule at T—80 min. but, because of subsequent holds, was in it for 3½ hours before liftoff.

Next Week . . .

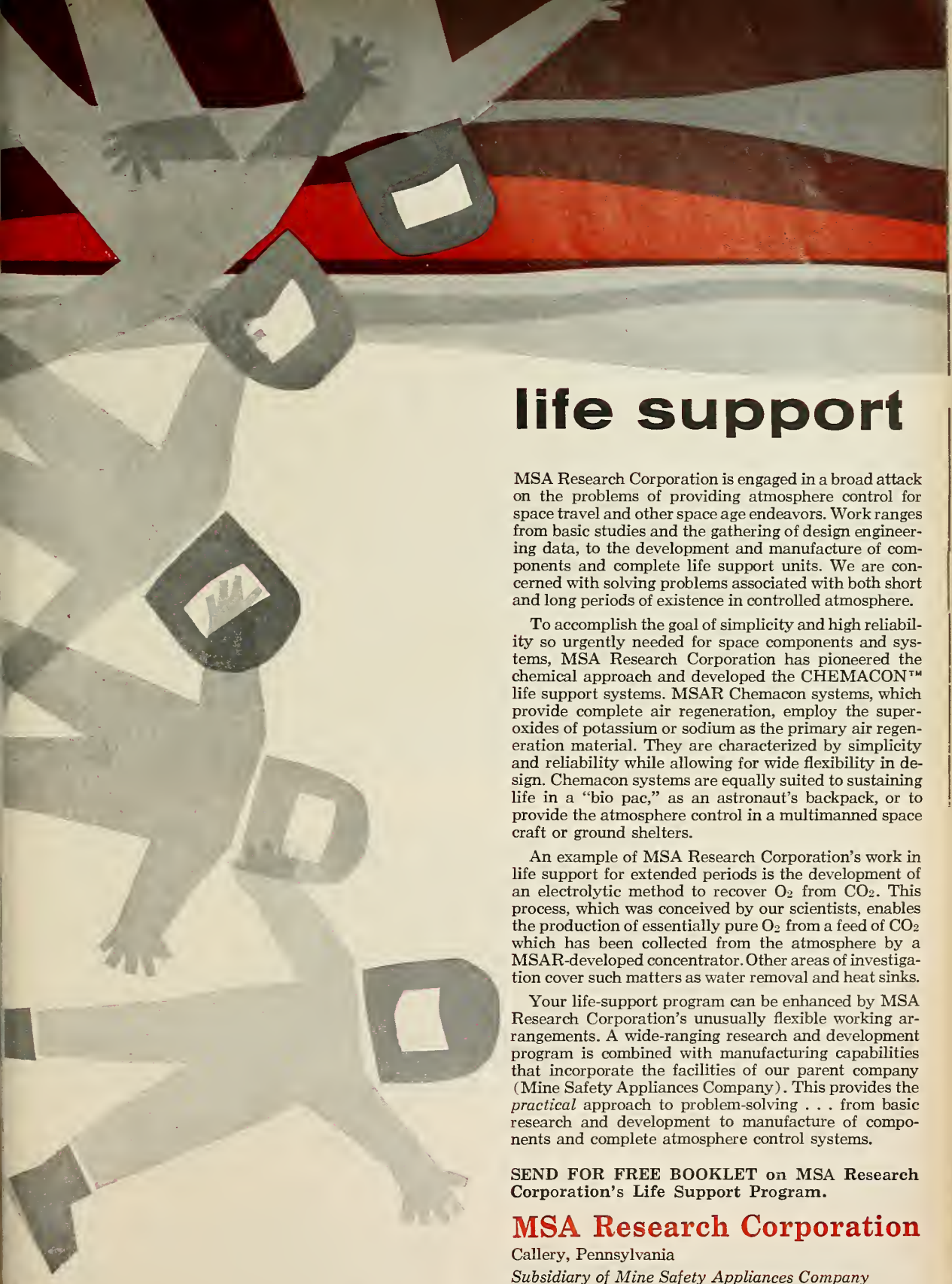
Missiles at Paris. In the June 5 issue of Missiles and Rockets there will be a special report on the Paris Air Show. An editorial team on-the-scene is ready to give full coverage to the missile/space activities at the show.

Shots of the Week:

The Air Force successfully fired an operational prototype *Titan I-J*, but had to destroy a *Minuteman* 90 seconds after liftoff on the ICBM's second flight.

The 24th success for *Titan* came in a flight May 24 which carried it 5000 nautical miles down the Atlan-

(Continued on page 18)



life support

MSA Research Corporation is engaged in a broad attack on the problems of providing atmosphere control for space travel and other space age endeavors. Work ranges from basic studies and the gathering of design engineering data, to the development and manufacture of components and complete life support units. We are concerned with solving problems associated with both short and long periods of existence in controlled atmosphere.

To accomplish the goal of simplicity and high reliability so urgently needed for space components and systems, MSA Research Corporation has pioneered the chemical approach and developed the CHEMACON™ life support systems. MSAR Chemacon systems, which provide complete air regeneration, employ the superoxides of potassium or sodium as the primary air regeneration material. They are characterized by simplicity and reliability while allowing for wide flexibility in design. Chemacon systems are equally suited to sustaining life in a "bio pac," as an astronaut's backpack, or to provide the atmosphere control in a multimanned space craft or ground shelters.

An example of MSA Research Corporation's work in life support for extended periods is the development of an electrolytic method to recover O_2 from CO_2. This process, which was conceived by our scientists, enables the production of essentially pure O_2 from a feed of CO_2 which has been collected from the atmosphere by a MSAR-developed concentrator. Other areas of investigation cover such matters as water removal and heat sinks.

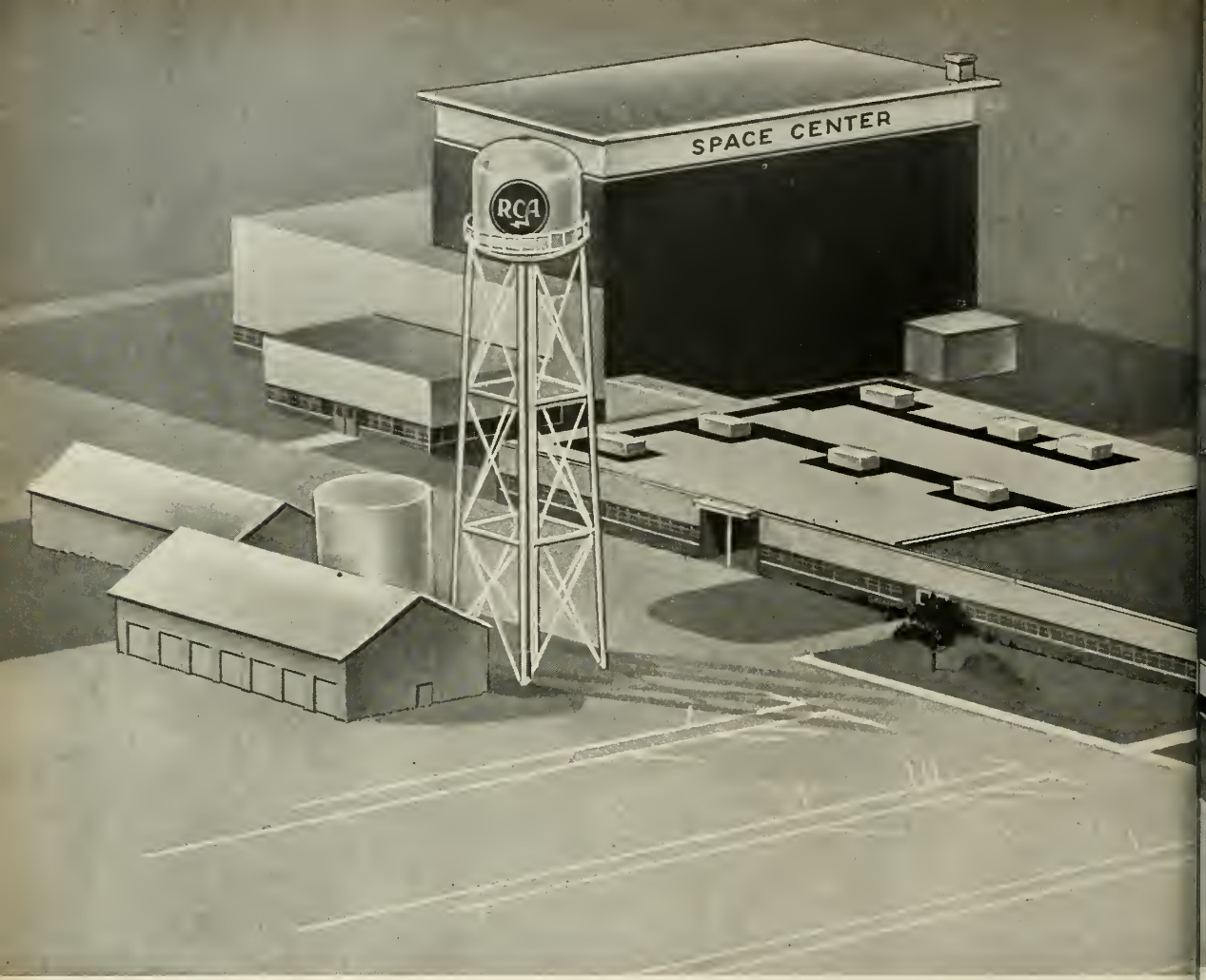
Your life-support program can be enhanced by MSA Research Corporation's unusually flexible working arrangements. A wide-ranging research and development program is combined with manufacturing capabilities that incorporate the facilities of our parent company (Mine Safety Appliances Company). This provides the *practical* approach to problem-solving . . . from basic research and development to manufacture of components and complete atmosphere control systems.

SEND FOR FREE BOOKLET on MSA Research Corporation's Life Support Program.

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New RCA Space Environment Facility Brings Outer Space Down to Earth...

...Will pretest coming generations of U.S. space vehicles and satellites at environmental extremes assuring reliable long life operation and optimum performance.

RCA expands its proved capability to meet the challenges of space-age technology with the construction of an advanced space environment center at Princeton, N. J. Here, today's *and* tomorrow's space vehicles and satellites can undergo a new degree of intensive and thorough testing prior to "launch" to achieve greater reliability in space.

Included in the new environmental equipment and facilities being built and installed at the RCA Space Center are the following advanced testing devices:

Vacuum-Thermal Chamber—measuring 28 feet in diameter and 25 feet high to accommodate the coming generations of space vehicles and satellites and meet all vacuum-thermal requirements.

Vibration System—provides 28,000 pounds peak force for sinusoidal, and 28,000-pound rms force for random motion testing.

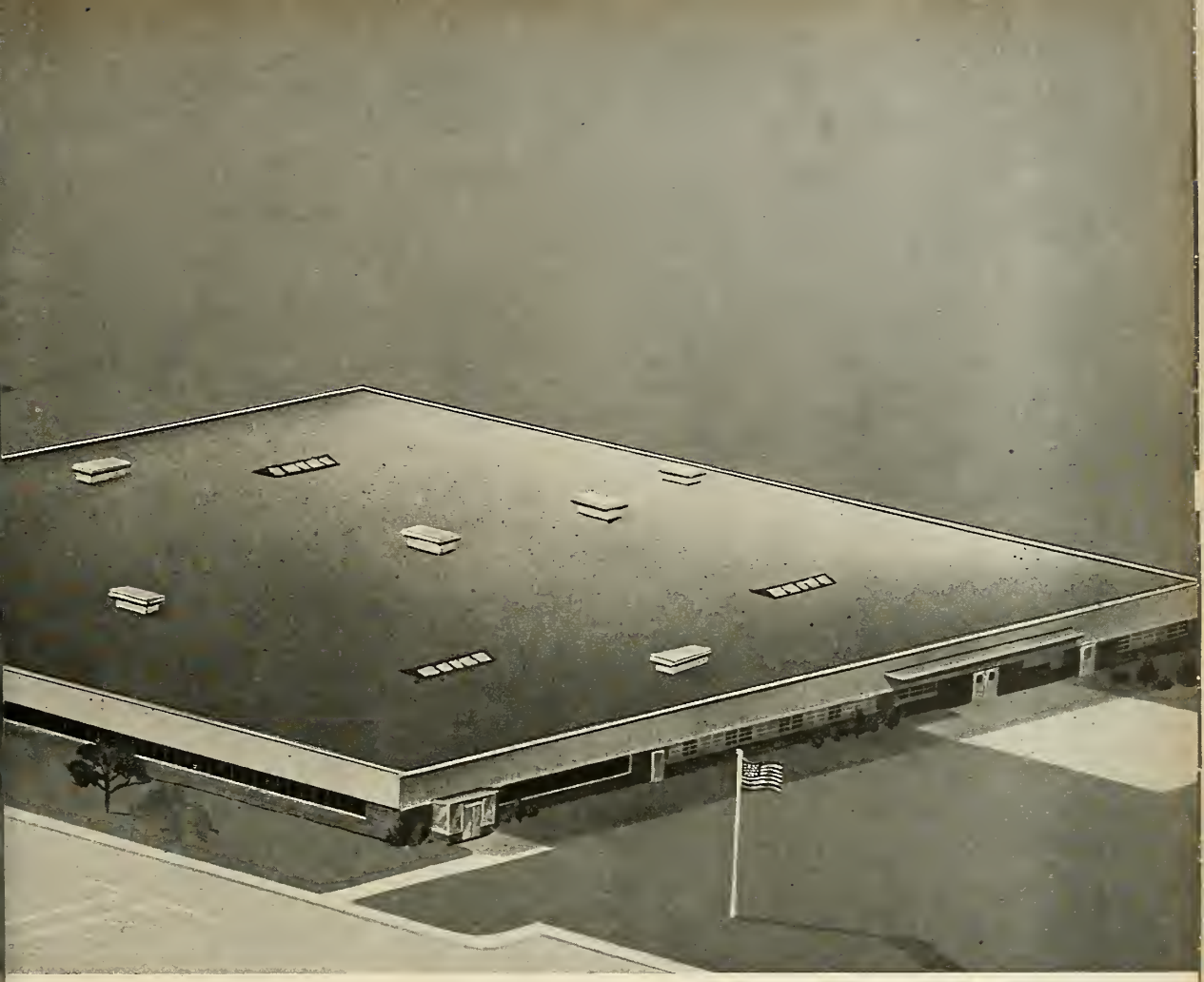
Temperature-Humidity Chamber—so versatile it can create virtually any thermal-humidity condition desired. Temperatures may be varied from —50° F to 250° F; humidity from nil to maximu

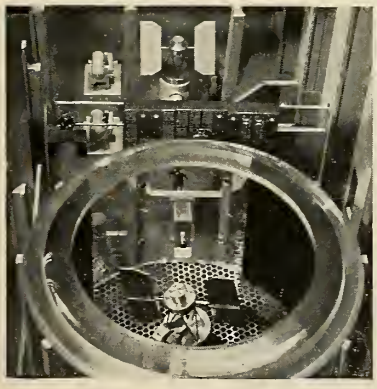
Rotary Accelerator—subjects subsystems of space vehicles a satellites to forces as high as 2500 g lbs.

The entire RCA Space Center, which contributed to the success projects such as SCORE, TIROS I, TIROS II and ECHO I, conti ues to be dedicated to the conception, development and producti of earth satellites, space vehicles and ground support and inform tion handling equipment. For additional information about RCA engineering talents and proved capabilities, contact the Manag Marketing, RCA Space Center, Box 800, Princeton, N. J. And, fo complete description of the new environmental facilities, write f your copy of the brochure "RCA Space Environment Center."

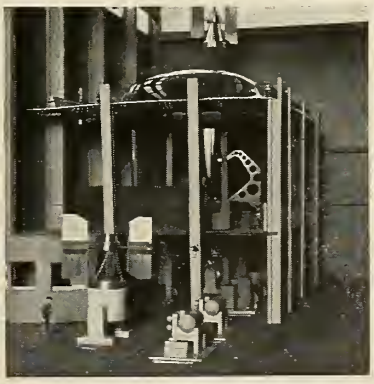
If you are interested in participating in the challenging opportunities that exist at the RCA Space Center, contact the Employment Manager, Astro-Electronics Division, Defense Electronic Products, Princeton, N. J. All qualified applicants are considered regardless of race, creed, color or national origin.



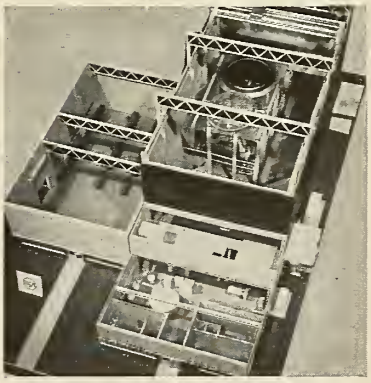




New advanced Vacuum-Thermal facility shawn in model has pumping system that can reduce pressure to 5 x 10^{-6} mm Hg within 24 haurs with a 3500-paund paylaad in the enclasure.



New Vibratian System will include 28,000-paund exciter driven by an amplifier capable af delivering 140 KW aver a frequency range af 25 ta 10,000 cps.



All existing enviranmental equipment will be haused here and a new high-bay assembly area provides facilities far assembly af an increased number af space systems.

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tic Missile Range. There have been seven partials and four completely unsuccessful shots in the program.

Instrumentation data showed the *Minuteman* was going well after second-stage ignition on May 19 when it suddenly veered off course. The destruct was not visible to observers at Cape Canaveral. The bird was programed for a 4600-mile flight.

The Army's *Redstone* satisfied all test objectives on a 200-mile jaunt down the AMR on May 17.

Juno II's Swan Song

In the last attempt to launch a *Juno II* satellite—the ionosphere beacon *S-45*—the upper stages apparently failed to fire May 24.

It was the second attempt to launch the 75-lb. NASA satellite. On the first attempt Feb. 24, the upper stages also failed to fire.

Juno II closed out its books with a record of three successful launchings, five failures and one partial success *(Pioneer III)*.

LeMay Will Add Toughness

The nomination of Gen. Curtis LeMay as the new Air Force Chief of Staff will put at the head of the Air Force one of the nation's toughest military men.

The blunt, 54-year-old Vice Chief of Staff and former SAC commander in chief, will succeed Gen. Thomas White on June 30.

Gen. Frederick Smith, Jr., 53-year-old commander of USAF in Europe and the Fourth Allied Tactical Air Force, was nominated to succeed LeMay as Vice Chief of Staff.

Appointment of LeMay is expected to result in powerful new emphasis on the development of advanced manned aerospace craft, as well as a greater build-up of strategic forces in being.

Tracking Advent at Sea

The shipboard tracking link of the Army *Advent* instantaneous radio communications system will be provided by Bendix Corp. under a $670,000 contract.

Advent will remain over a fixed point at the equator by orbiting the earth at an altitude of 19,300 miles with a 24-hour period.

GE Ordnance Department will develop the antenna for the seaboard terminal. The antenna device will have a three-axis drive to permit uninterrupted satellite tracking despite pitch and roll motion of the ship.

The two shore stations for *Advent* will be at Fort Dix, N.J., and Camp Roberts, Calif.

Soviet Academy Downgraded?

The recent resignation of the Soviet science chief may be part of the shakeup which has put all Soviet research under a military-dominated "supercommittee" (M/R, April 24, p. 34).

Alexander N. Nesmeyanov, 62, vacated his post "at his own request" after being president of the Soviet Academy of Sciences since 1951. He directed the space program which led to the orbit and return of Yuri Gagarin April 12.

The Academy's position as leader of Soviet research has apparently been downgraded with the new emphasis on practical application of research.

New president of the Academy is Matislav V. Keldysh, 50-year old mathematician and expert in mechanics and computing techniques.

Word From Explorer, Tiros

Explorer XI, the gamma-ray astronomy satellite launched April 27, is giving good telemetry on direct readout, but the tape-recorded data is reported to be poor in quality.

Research and Engineering for

MAN IN SPACE

The feature section of this special issue starts on page 32.

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The satellite's orbit, which reaches an apogee of 1111 miles, brings it into the lower Van Allen belt for a good part of the time and the Van Allen radiation limits its usefulness near apogee. The best telemetry comes when the perigee is near a direct readout station.

The satellite has begun the tumbling motion necessary for a complete scan of the sky. The change to the tumbling motion required about three weeks from launch.

Tiros II, in orbit six months, is still transmitting. The narrow-angle television camera has been operating perfectly since launching last Nov. 23, NASA reports.

Infrared data is still being received. But for the last month the quality of the IR signal has been poor, apparently because of low voltage.

Echo II Design Verified

The G. T. Schjeldahl Co. has completed the first inflation tests of the 135-ft. rigidized *Echo II* balloon satellite.

The tests took place in the same hangar used to test the *Echo I* balloon at Schjeldahl's Northfield, Minn., plant before it was launched last year.

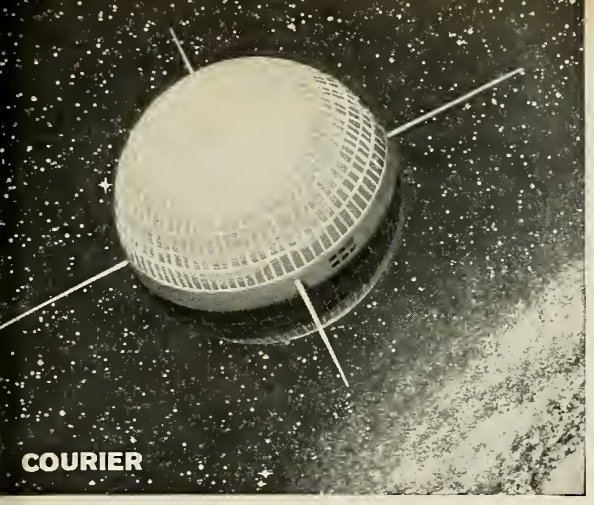
Echo II consists of a three-ply laminate made of .20 mil aluminum foil bonded to Mylar plastic .35 mil thick. Weighing 500 lbs., the balloon folds into a 40-in. spherical metal container.

By contrast, *Echo I* was only two layers, Mylar inside and aluminum outside, with total thickness of .55 mil, and only 100 ft. in diameter. The *Echo I* balloon, weighing 135 lbs., packed into a magnesium container only 26½ in. diameter.

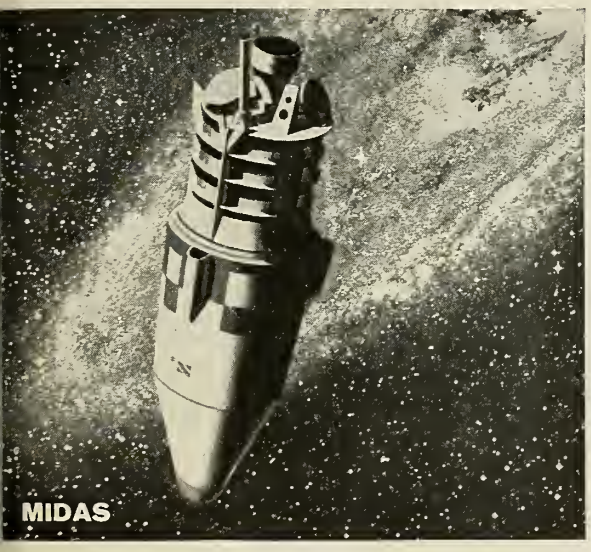
Schjeldahl verified the structural design of the bigger sphere by inflation to a tensile stress of 4000 psi for four hours. Then it was tested to destruction at 18,000 psi, proving a design safety factor of 4½.

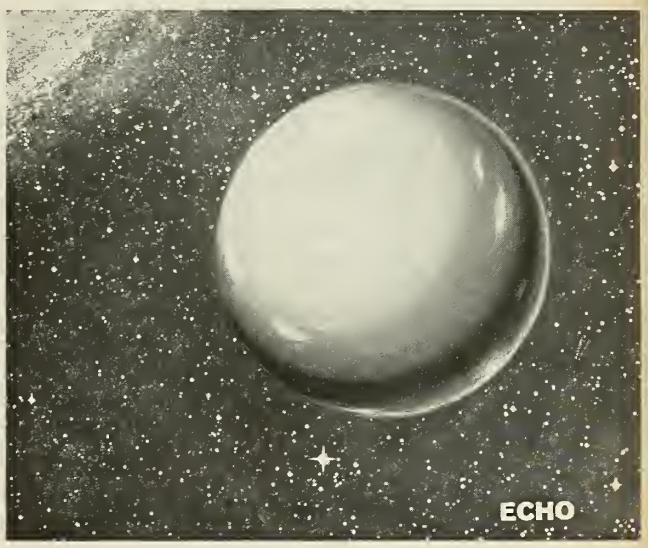
The satellite is to be launched on a ballistic trajectory this fall with a *Thor* booster. The first orbital launching is scheduled for mid-1962, with use of a *Thor-Agena B* vehicle, down the Pacific Missile Range.

Echo II is expected to have much longer useful life than *Echo I*, which is still in orbit. *Echo I* can be used as a communications reflector but the quality of the reflected messages has degraded because of wrinkles in the surface.









Philco Achievements in Space Technology

Philco has made many major contributions to the nation's vital space programs. COURIER, the world's first advanced communications satellite, was designed and built by Philco. Philco played a major role in the development and installation of the complex communications, command, tracking and data systems for the DISCOVERER program. Space-borne and ground communications systems for MIDAS and other satellites have been Philco designed. Philco developed and installed the tracking and receiving systems for the Air Force Passive Satellite Relay Link, which utilizes the ECHO satellite. In the field of human factors engineering, Philco has developed personnel subsystems for several major space projects. Philco also produces the world's largest 3-axis satellite tracking antennas.

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Piercing the plasma sheath...

When ICBMs, satellites or space probes re-enter the earth's atmosphere, frictional heating is so intense that air surrounding the vehicle becomes a "plasma sheath." This acts as a barrier to conventional radio telemetry. AVCO/RAD has developed a Direct Re-entry Telemetry (DRET) system for the U. S. Air Force. The DRET system has been flown on Atlas and Titan ICBMs and has successfully transmitted signals to airborne monitoring equipment. Engineers and scientists at AVCO/RAD are also working on techniques for continuous communications with re-entering manned vehicles, as well as on other conditions in which a plasma barrier exists and where signal penetration is required.



Airborne re-entry tracking team of Avco's RAD Division monitor an Avco Mark 4 re-entry vehicle launched by Titan ICBM.

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Soviet Manned Spacecraft Is Winged



EVIDENCE mounted this week that the manned Soviet Cosmic Ship *Vostok* was an early prototype of a winged military spacecraft.

Informed sources said new information matches earlier data and reports that the *Vostok* was a winged vehicle which used glide techniques to re-enter the atmosphere and land in a preselected field after orbiting the earth.

The new information was based in part on fairly detailed drawings appearing on recently-released Soviet postage stamps, which are usually considered by the intelligence community to be highly accurate. Up to now the Russians have not disclosed the precise configuration of *Vostok*.

The drawings depict the *Vostok* as a glider similar in concept to the Air Force *Dyna-Soar*. What appears to be the upper stage of the *Vostok* booster was depicted as having fins, as will the modified *Titan II* to be used for launching *Dyna-Soar*.

The drawings also indicate that the *Vostok* was similar to earlier spacecraft used by the Russians to launch dogs into orbit and return them to earth (M/R, April 17, p. 14).

The growing evidence that Russia is successfully launching winged spacecraft is of great concern to U.S. Air Force officials.

• **Military significance**—Such launchings have a two-fold significance:

—They mean Russia has already solved the difficult problems of maneuverable re-entry. These are the problems that the long-starved *Dyna-Soar* program is aimed at solving over the next two to five years in preparation for designing operational military spacecraft.

—They offer new evidence to support the already widely held conviction in the Air Force and many technical circles that the Soviet space program always has been aimed directly at achieving military dominance in space.

Wings or other surfaces that would provide lift are considered essential design features for military spacecraft that would operate on missions in the atmosphere as well as in space. These features are not considered essential for purely scientific spacecraft which do not have to maneuver or land at preselected points.

Military planners stress that military domination in space between the earth and the moon can only be achieved through control of the air and space near earth with military craft operating in both environments.

They contend that the development of winged military spacecraft by the Soviets would enable them to completely deny space to U.S. satellites and spacecraft and pose the threat of even denying the United States the ability to use space for R&D tests.

Moreover, military strategists contend that military spacecraft would enable Russia to pose an alternate strategic threat to currently-planned land, sea and air-based systems. This could be done with orbital or aerospace bombers.

In brief, Russia in a nuclear war would have the last button in space. ⌗



NEW SOVIET STAMPS depict (detail above and at upper left, below) a winged Vostok on top of what is apparently the upper stage of a huge Soviet booster. Other stamps show (bottom left) a winged Sputnik IV spacecraft launched May 15, 1960 and (bottom right) a winged dog-carrying Sputnik V launched Aug. 19, 1960. Czech stamp (upper right) depicts Soviet Feb. 12 Venus probe.

New Gap: U.S., USSR Astronomical Units

U.S. AND SOVIET radar-bounce-off-Venus measurements of the astronomical unit differ by 88,000 miles.

And the United States says Venus' rotation is very slow—perhaps with a period of 225 days—while Russia has calculated a period of 9 to 11 days.

Both nations performed the experiments between March and May, when the earth and Venus were passing close to one another. The closest distance—or inferior conjunction—was on April 10, when the planets were separated by 26.3 million miles. Inferior conjunction occurs every 19 months.

The U.S. experiments were conducted by Jet Propulsion Laboratory, operated by California Institute of Technology for the National Aeronautics and Space Administration. The Soviet Academy of Sciences sponsored the work reported by Academician Vladimir Kotelnikov and Prof. Isoif Shklovskiy. The location of the Soviet work was not disclosed.

JPL reported last week that its experiments with the Goldstone 85-ft. deep space antennas at Goldstone, Calif., developed a value of the astronomical unit—the average distance between the sun and the earth—of 92,956,000 statute miles, plus or minus 1000 miles. The work was done under the supervision of Walter K. Victor and Robertson Stevens.

Tass quoted the Soviet Academy as reporting May 11 that the unit figures out to 149,457,000 kilometers—which equals 92,868,000 statute miles.

JPL said it transmitted on a frequency of 2388 megacycles. Tass said only that the Soviet transmission was in the middle of the decimeter band—apparently in the neighborhood of 1000 megacycles.

JPL said the frequency of the return signal was spread from 5 to 10 cps, indicating that the rotation rate is extremely slow—perhaps as slow as once per Venusian year of 225 earth days. Victor said the final results of the spin rate calculation depend on the yet-to-be-figured orientation of the spin axis, which he said is difficult for such a slowly rotating body.

Kotelnikov and Shklovskiy said their observations indicate that some reflecting zones on the planet's surface differ by as much as 80 meters per sec. If it is assumed that the rotation axis is perpendicular to the line joining the earth and Venus, they said, the period approximates 11 days. But if the axis is inclined as predicted by the U.S. astronomer Gerard Kuiper, they commented, the period approximates 9 days.

The Tass report gave neither the frequency of the Soviet transmission nor the amount of the band widening. However, it said full results will be published later in scientific journals.

JPL began bouncing signals off Venus March 10 and continued the experiments daily through May 10. Its signals indicated Venus has a reflectivity of 12%—similar to that of the earth.

R. J. Parks, director of JPL's planetary exploration program, told M/R that success of the experiment in refining the astronomical unit was "the payoff to a multimillion-dollar calculated gamble" in connection with design of the first U.S. Venus spacecraft, *Mariner,* on which JPL began work last year.

"Our whole design was based on the assumption that we would get a better determination of the astronomical unit before the vehicle flew," Parks recalled.

Victor, co-director of the Venus radar experiment, said results would make possible:

—Acceleration of planetary exploration by at least one and a half years.

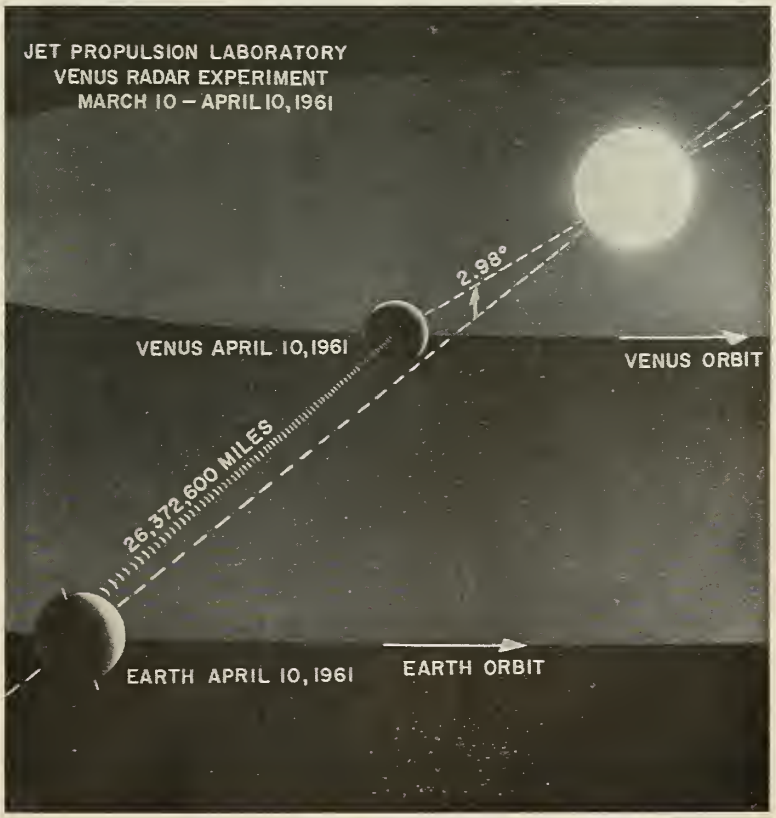
—Simplification of spacecraft design.

—Savings of millions of dollars in research and design.

—An increase in spacecraft communication range to 300 million miles (compared to about 20 million achieved with *Pioneer V*).

Without the new figure for the astronomical unit, Victor said, the first U.S. Venus probe next year would miss that planet by at least 20,000 miles, and another attempt could not be made for 19 months.

A "significant simplification" in design of planetary probes will be possible, he said, because target planets now can be located with such high accuracy that "it no longer is necessary to rely on development of a long-range terminal tracking device. Instead, the already developed midcourse guidance system can be used to guide the spacecraft." ⌗



JPL CHART shows how signals were bounced off Venus to measure astronomical unit.

Orbital Work Can Aid Moon Landing

RENDEZVOUS and orbital operations can help speed the U.S. manned landing on the moon, a high space agency official says.

Milton W. Rosen, deputy director of NASA launch vehicle programs, told the House Space Committee last week that orbital operations might extend the capability of *Saturn,* and might speed the achievement of a permanent or long-term manned space station in orbit.

However, Rosen said orbital operations will require extensive development to achieve operational capability. The first step in the development, he added, would be an orbital docking demonstration, in which two payloads would be joined in orbit.

It is understood that NASA plans to launch two *Agena B* satellites for the demonstration, if funds are provided to obtain the launch vehicles in Fiscal Year 1962. Rosen said under questioning he believed $8 million should be appropriated.

One of the advantages of rendezvous and orbital operations is leapfrogging the lengthy process of "man-rating" the *Nova* launch vehicle, Rosen contended. Instead of waiting for the extensive testing required to make the *Nova* safe for manned flight, its upper stages could be launched into orbit as an unmanned carrier. Then a manned spacecraft be carried into orbit by a man-rated *Saturn C-2.*

The manned spacecraft and the upper *Nova* stages could then be locked together and launched from orbit.

• **Other possibilities**—Another use of orbital operations might be to launch about six *Saturn C-2* vehicles to carry and transfer fuel and finally a manned spacecraft to an orbiting *Saturn* upper stage. It has been reported elsewhere that the *Saturn S-IV* stage might be considered for such an operation. It would carry sufficient propellant for braking down to a soft landing on the moon and lifting back off for return to earth.

Rosen said it might be possible to land men on the moon by such a method with a smaller and less expensive launch vehicle. However, he cautioned that the operation is extremely complex and, in the end, it might not save time and have the desired reliability.

A third application of rendezvous, Rosen said, would be for rescue of the crew of a disabled *Apollo* spacecraft in orbit. If the *Apollo* should prove incapable of making a safe descent, a rescue vehicle could rendezvous, attach a powered capsule, transfer the crew and return safely to earth.

The same technique could be used for periodic rotation of the crew of a permanent space station.

Harold Brown, director of defense research and engineering, said the Defense Department is also interested in rendezvous techniques. He said there are military requirements for inspecting possible hostile satellites. ⁂





Goodyear Proposes Expandable Structures as Space Stations

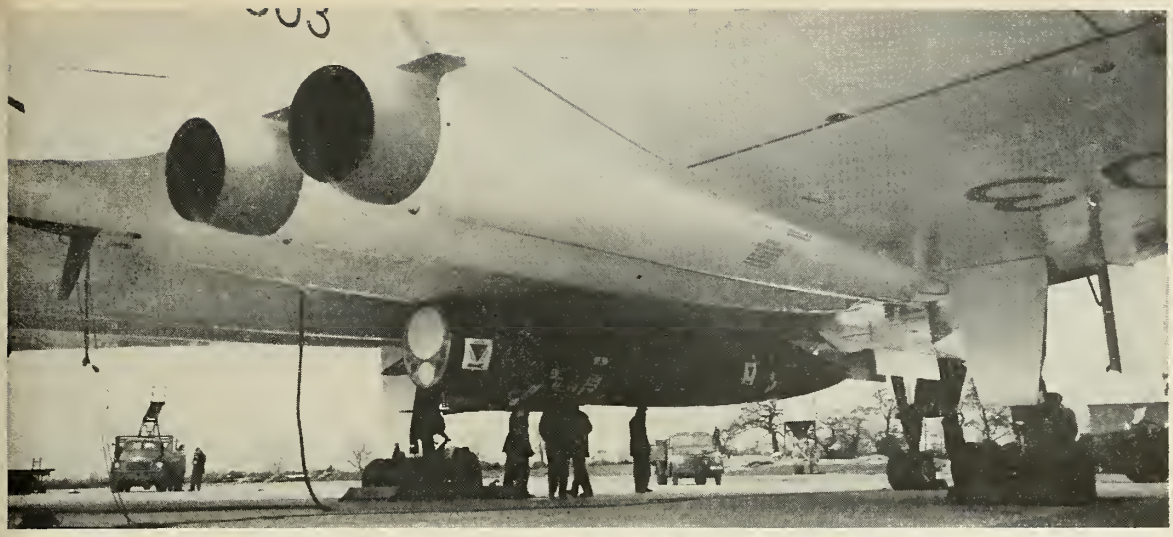
EXPANDABLE structures—folded within a rocket nose cap like the Echo balloon satellites—are being proposed for use as orbiting space stations.

In a presentation before the House Space Committee last week, Goodyear Aircraft Corp. said it would be possible to produce almost any size or shape for the space station by patterning or weaving the fabric structure in the desired final configuration. Inflation in orbit is accomplished with a suitable gas.

The major advantage of the expandable structure is that it can be assembled and inspected at the factory. Then it is deflated and packaged into a canister for handling and packing within the booster payload.

Goodyear said shapes such as spheres, ellipsoids, paraboloids, cylinders and other bodies of revolution can be fabricated in single-wall structures by proper design of the pattern. In addition, Goodyear says, it has developed a method of fabricating double-wall structures by weaving the two wall fabrics simultaneously with interconnecting filaments.

The ability to fold an entire space station into the dimensions of a relatively small nose cone would make it possible to place an entire manned space station and re-entry vehicle in orbit.



OPERATIONAL-SIZE BLUE STEEL shown slung under Vulcan will have nuclear warhead.

Blue Steel Put Into Full Production

Avro's system is Europe's only inertial missile in mass production; weapon is 'core' of U.K. defense pending skybolt

by Bernard Poirier

BRITAIN'S air-launched *Blue Steel* strategic missile has been put into full production by A. V. Roe & Co. Ltd., in an effort to outfit all serviceable Vulcan bombers as they become available.

At the same time, the evaluation program for the key weapon is being pressed at Australia's Woomera range.

Significant breakthroughs by A. V. Roe and its subcontractors during the past year have given *Blue Steel's* makers the only inertial missile production line in Europe. They have also provided the West with its only present weapon with strategic peripheral (stand-off) capability from aircraft.

Blue Steel's principal advantage, according to an Avro spokesman, is its programed ability to feint and maneuver evasively during flight to an assigned target area.

Two subcontractors have made important contributions to the Avro effort:

• **Elliott Brothers** (London) perfected the purely inertial navigation system which instantaneously adopts position fix at launch and commands servo reactions from parametrically acceptable pick-offs while in programed flight.

• **Bristol Siddeley Engines** designed and developed a new Stentor liquid rocket motor with longer burning time and reliable performance to satisfy requirements for evasion-under-power.

Since the Stentor was adopted, unofficial reports have placed *Blue Steel's* range at 500 miles. The British will station Vulcans armed with the missiles at widely scattered bases, ready for deployment in any direction.

British military conviction that *Blue Steel* could meet its objectives has solidified Avros' position, which earlier was subjected to considerable political fluctuation. For a time, the missile's future was balanced against America's Douglas *Skybolt*.



TWO-FIFTHS-SIZE test model of the Blue Steel is hoisted aboard bomber.

But *Skybolt* suffered cutbacks in the U.S. defense budget (M/R, May 8, p. 8), and when its slippage became a certainty British Minister for Defence Harold Watkinson ordered a large number of *Blue Steels* into production.

"It is a weapon for the present," Watkinson said, "and for the next few years until *Skybolt* enters service."

Top British officials, while expressing regret that the *Skybolt* system had been slowed up, asserted that the nuclear *Blue Steel* has "a very powerful punch indeed."

• **Britain's defense core**—The *Blue Steel* system outgrew its early testing facilities at Aberporth, Wales, and elaborate and farflung installations had to be built for it at Woomera.

A. V. Roe acquired buildings and facilities at Edinburgh Field, near Adelaide, about 250 miles south of the range itself. Telemetering stations were established several hundred miles apart along the flight area.

The system proved that it could arrive at a target well beyond known antiaircraft missile range, recover from each programed evasive tactic and follow its assigned course. Thus, dispersed, mobile and very difficult to defend against, *Blue Steel* is considered "the core of Britain's aerial defense." ❖

Telemetry Can Be Over-Standardized

Majority of panel of industry experts says standards—while badly needed—must be flexible; Rechtin named telemetry man of year

CHICAGO—Industry experts are warning that premature and rigid standards can throttle the progress of telemetering.

Several members of a workshop panel on telemetry standards at the National Telemetering Conference voiced their concern over this problem. These panelists and members of the NTC Standards Activation Committee—who have been studying the problem for some time—agreed that standards have not kept pace with the industry. They are badly needed, but they must be flexible and loose enough so as to aid rather than impede progress.

The Standards Committee apparently was not unanimous in this view, however. A minority held that standards should be more rigid and even, perhaps, become military specifications.

In pointing out the changing nature of telemetry, one expert said that its role had grown from a service function—gathering failure data from R&D missiles—to being the primary element in a space probe. Because the problems are very different, systems must be different.

Space systems will have to be able to handle increasing amounts of data over ever-increasing distances. As a consequence, one panelist predicted, the performance of the telemetering link must be increased several orders of magnitude over the next 4 to 5 years.

• **Rechtin honored**—Social highlight of the NTC was the annual award banquet. Dr. Eberhardt Rechtin, chief of the Telecommunications Division of JPL, was named as the telemetry man of the year. Rechtin has been responsible for much of JPL's space communications and tracking efforts. Banquet speaker was Dr. Charles S. Draper, inertial guidance pioneer, of MIT.

Luncheon speakers were William J. Coughlin, editor of MISSILES AND ROCKETS and Dr. David S. Potter, research director of GM Defense Systems Division. This year's chairman of the NTC was Robert G. Brown, director of AC Spark Plug's Advanced Development Department.

Workshop sessions highlighted the technical program. The status of telemetering in Europe was discussed by a panel of eight delegates brought here for the occasion by the Air Force. Greece, Belgium, Denmark, the Netherlands, Britain, Germany, Italy, and France were represented in the group.

One panel of educational experts discussed the need for training engineers and technicians in using telemetry as a tool in measurement decisions, and how this need can be met.

Another unique feature of the NTC was a technical session and exhibit tour held for some 600 Chicago high school science students. This reportedly was the first time such students had been allowed to participate in a professional scientific conference.

Although interest is still high in digital telemetering systems, it was evident at the conference that the original enthusiasm for PCM may be cooling off somewhat. According to some spokesmen, the industry is suffering from "hyperdigitosis"—the conviction that all problems can be solved by a liberal application of digital techniques.

Older techniques are being dusted off and improved upon and unique approaches being devised to handle specific problems. PCM, although certainly getting the most attention in both technical papers and exhibits, is not necessarily the darling of the industry that it has been previously.

• **Paper highlights**—Transducer manufacturers should immediately begin programs to supply adequate digital transducers for measurement of pressure, motion, temperature and acceleration, said Fred S. Howell, Zeigler Corp. His paper described the results of a detailed analysis of the use of transducers in ballistic missile telemetering. Classifying measurements into four groups, Howell indicated how each could best be handled.

The data transmission system for the gamma ray astronomy satellite was described by two NASA scientists, Olin B. King and Frank Emens. Pointing out the complexity of the experiment and the high initial bandwidths involved, the authors showed how optimum design allowed an overall power consumption level of less than 1.5 watts.

In another paper, King described the unique SS-FM telemetering system developed to solve the problem of vibration measurements in the *Saturn* program. The high data bandwidth capability of the system is of special interest to the industry.

Requirements for the instrumentation of *Dyna-Soar* were outlined by W. M. Moore and W. D. Mace of NASA. Their paper included the types of measurements that would be required in the vehicle and a description of the airborne systems which might be developed to meet these requirements.

Max A. Lowy, Gulton Industries, delivered a paper on an approach to self adaptive telemetry systems. He described a possible system which would transmit only data of primary interest with optimum utilization of data bandwidth.

The problems of synchronization in PCM systems were outlined in a paper by Merwin W. Williard of Dynatronics, Inc. He presented a method of word and frame synchronization detection which would allow rapid sync acquisition and still maintain synchronization with reliability in the presence of high noise levels.

One technical session was devoted to the use of telemetry in underwater measurements and another to bio-medical telemetering.

Conventioneering engineers could get their money's worth in Chicago this week. Globe Com V ran concurrently with NTC and communication experts shared their time between the two conferences. Thursday and Friday, Electronic Industries Association took over the stage with its annual convention. ⌗

GOP Fails to Get More Polaris Subs

HOUSE Republicans this last week sought belatedly to amend the GOP record on the *Polaris* submarine program.

The House Republican Policy Committee sought to add six more *Polaris* submarines to the $12.3 billion defense procurement authorization bill as it came up for action on the House floor.

The House passed the bill including $393 million for bombers added by the House Armed Services Committee on top of the request submitted by President Kennedy. The House rejected the GOP *Polaris* amendment 105 to 58.

The GOP amendment added an ironic footnote to history. The Eisenhower Administration consistently cut back Navy requests for *Polaris* submarines. However, the Kennedy Administration has accelerated the *Polaris* sub construction program and added 10 more to the final Eisenhower budget proposals.

Rep. Charles S. Gubser (R-Calif.) originally attempted to add six more *Polaris* subs on top of the Kennedy requests when the Armed Services Committee was voting on the bill. The price-tag on the proposal was $697 million.

Gubser argued that the extra authorization should be included in order to insure the continuity of the *Polaris* submarine construction program. He noted that so far the Kennedy Administration has not committed itself to build more than 29. The Navy wants a fleet of 45.

The House Republican Policy Committee later agreed to support Gubser in trying to add the amendment again on the House floor.

• **Too "unrealistic"**—Chairman Carl Vinson (D-Ga.) of the Armed Services Committee told the House six more subs were "unrealistic" because they could not be built for several years even if the money were authorized. He said Congress should not try to decide unnecessarily now what would be needed in the future.

The authorization bill itself cleared the House with little change from Kennedy's requests other than the addition for bombers. The Senate already has passed a similar bill except for the addition of $468 million for bombers. The bill now must go to a conference committee for adjustment of differences.

The additions for bombers resulted from doubts raised by members of both the Senate and House Armed Services Committees as to the wisdom of ending production of all manned bombers in the United States.

The production cut-off originally was proposed in the final Eisenhower budget. Kennedy went along with it.

However, congressmen contended that shutting down bomber production would be premature. They said that the incoming missile systems still were not reliable enough. And they said more bombers will be needed to make the *Skybolt* air-launched ballistic missile worthwhile.

Behind the congressional arguments also was concern caused by the Administration cut-back in the B-70 R&D program.

Except for the B-70, the United States does not have a new manned strategic bomber under development. A number of Air Force officials have repeatedly pointed out the need for new manned bombers to combat mobile missile systems and to provide a nuclear second strike hunter-killer force.

As for reliance on the big missiles, Air Force Secretary Zuckert bluntly told the Senate Armed Services Committee:

"I think that it is very important that the people of this country do not get the feeling that we have a real missile capability or that we are going to have it for the next couple or three or four years. In the first place there are not a lot of them today. There are very few operational, and there will be few operational in my opinion for some time to come." ⁂

Highest Priority Urged for the Rover Nuclear Rocket

THE PROJECT *Rover* nuclear rocket program is being recommended for a DX priority, the nation's highest.

In a staff report submitted by Chairman Overton Brooks (D-La.), the House Space Committee calls for selection of engine and vehicle contractors by the National Aeronautics and Space Administration "at the earliest practicable date."

The committee also urges:

—Providing the joint NASA-Atomic Energy Commission Space Nuclear Propulsion Office "with sufficient authority effectively to direct the progress" of *Rover*.

—Using the talents of the AEC's Los Alamos Scientific Laboratory in research on advanced reactors as much as possible, leaving the engineering work to industrial contractors.

—Restudy of the funding level for Nevada facilities with the objective of providing adequate support and test facilities when needed.

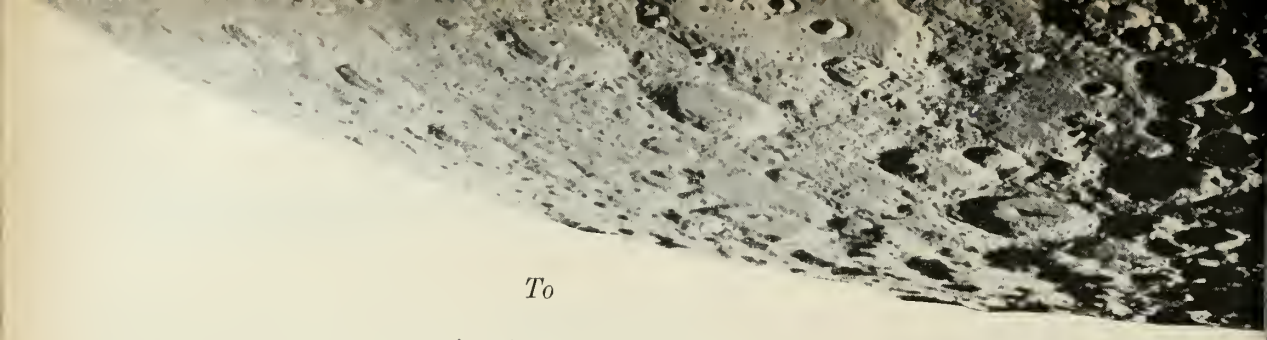
The committee cited administrative delays in *Rover* last fall in support of its call for giving more authority to the SNPO, headed by Harold B. Finger.

Results of the *Kiwi-A3* test firings were so good last fall that SNPO decided to cancel a proposed NASA *Nerva* flight engine design study contract and proceed immediately to the selection of an engine contractor. The aim was to speed the program by several months.

By the end of November, the technical statement of work was completed. However, the requests for proposals were not sent to the engine contractors until February. The committee said details bearing on method of selection, procurement principles, method of financing and the roles to be played by various field elements of AEC and NASA caused disagreements that resulted in a delay of more than two months.

"Delays of this nature raise questions as to whether the SNPO functions at a sufficiently high management level that decision bearing upon matters requiring the cooperative effort of AEC and NASA can be made in an orderly manner," the committee commented.

The committee reported it is encouraged by the decision of NASA to begin a development program for the *Nerva* engine. But it added, "The committee is not reassured about the program for development of a suitable vehicle. Industry witnesses have stated that solution of the inevitable interface problems between engine and vehicle requires that both development programs proceed in parallel." ⁂



To

pinpoint

a NASA

payload



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Motorola

systems

reliability

CALTECH'S JPL RANGER, to carry research instrument packages to the moon, will rely upon precision design, construction, testing and performance of Motorola electronic equipment. Comprehensive measurements of operational and navigational data aboard will be assembled for transmission by its Flight Data Encoder. An all solid state Transponder generates the telemetry carrier, receives ground commands, and translates carrier frequencies for two-way Doppler velocity measurements. ☆ In laboratories and at launch site, Payload Test Sets will check out the spacecraft RF communications system. At NASA's transmitter and receiver sites, Calibration Beacons will check command transmitter performance and radiate precise signals to test telemetry receivers. ☆ Motorola's participation in Ranger lunar probes demonstrates its space communications capabilities for frontier programs.

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Technical Countdown

ASTRONAUTICS

Re-entry Corridors Vary Considerably

A lift/drag ratio of 2—as in a *Dyna-Soar* glider—would enable the pilot of a returning spacecraft to vary his landing point up to 9000 miles longitudinally and about 2500 miles laterally—so that the returning vehicle might land anywhere in the continental United States. NASA says that with an L/D ratio of 0.4 to 0.7—as indicated for the *Apollo*—control will be limited to about 1000 miles longitudinally and a few hundred miles laterally.

ADVANCED MATERIALS

BeO Coating Breakthrough Announced

Numec has deposited a coating of non-porous beryllia on small particles of uranium dioxide in layers up to 100 microns on 100-micron-diameter particles. The BeO coatings have a potential in nuclear rockets because their thermal conductivity is higher than that of most oxide coatings.

Solid-Fuel Mixer Developed

A vertical mixer with interchangeable mixer bowls, which cut mixing time by quicker loading and unloading operations, has been developed by J. H. Day Co. Three vertical agitators overlap and intermesh to increase efficiency some 30 to 80%, Day reports.

Saturn Bulkheads Explosively Formed

Explosive forming of 70-in. hemispherical *Saturn* bulkheads is under way at Ryan Aeronautical Co. A 13-ton concrete and epoxy die has been fabricated to form the one-piece aluminum components.

Hi-Temp Plastic Breakthrough Soon

A breakthrough in high-temperature plastics to permit use of an all-plastic thrust chamber in liquid-propellant rocket motors will be announced shortly. Experimental plastic chambers have been successfully test-fired at medium chamber pressures. To eliminate ablation technique which alters the cross-sectional area of throat, one solution is a plastic which conducts surface heat through conductive filaments imbedded in the material. The plastic chamber is expected to be used first in low-pressure systems for vector control and positioning of space vehicles.

Largest Aluminum Casting Reported

One of the largest aluminum alloy hydrodynamic structures ever cast is reported by U.J.B. Foundary and Pattern Co., Long Beach, Calif. The modified conical structure, 5½ ft. high, 4 ft. in diameter at the base and 2 ft. at the top, had a maximum wall thickness of 0.375 in. Integral stiffeners and bosses required sections ranging in thickness from ¼ to 4 in.

New Type Air Bearing Tested

Boeing engineers have developed a new and simpler arrangement for using air as a bearing surface, bypassing some of the method's previous disadvantages. Using step-bearings supported by air from a single hole rather than from multiple tiny orifices, the new device is reportedly cheaper and more rugged. Test units have been run at speeds up to 100,000 rpm in temperatures from −330 to +600°F.

ELECTRONICS

IR Advances Needed

The Air Force is looking for a way to boost capability and accuracy of infrared-based tracking and reconnaissance devices. Latest move is award of an R&D contract to Electro-Optical Systems for thin-metal-film, bolometer-type IR detectors. The main objective is a state-of-the-art advance from single-detection elements to multi-element, probably mosaic-type, arrays.

PILAC Clocks Nuclear Events

Los Alamos Scientific Laboratory has successfully clocked nuclear events occurring in a nanosecond through use of a device called PILAC—Pulsed Ion Linear Accelerator. The system incorporates a compression magnet and converts a steady, or d-c, current of high-energy ions into a train of intense, equally spaced bursts, each only a fraction of a nanosecond long.

Minuteman Circuits to Production

First production run for high-reliability circuit assemblies for *Minuteman* electronic systems is scheduled to start soon under a contract just awarded to Melpar, Inc. by Autonetics. Melpar will produce the electronic building blocks for guidance, control and checkout systems. Components to be used were developed in a unique two-year program for upgrading reliability of semiconductors; the effort is expected to yield components 100 times more reliable than those available a short time ago.

Perpetual Fuel Cell Next?

An experimental regenerative fuel cell which can be designed to deliver thousands of kilowatts and operate indefinitely is under development at Hoffman Electronics. A working model of the sodium amalgam-chlorine primary fuel cell, not much larger than a man's wrist watch, produces 1 watt of power, compared with ⅔ watt from a flashlight cell. It also can use bromine to generate electricity by chemical reaction, according to Hoffman.

PROPULSION

Toxic Leakage Detector Revealed

An electrochemical instrument that will detect air mixtures of highly toxic UDMH (unsymmetrical dimethyl hydrazine) has been developed. Capable of measuring UDMH to 1 part in 4 million, it far exceeds human capability of detecting to about 8 parts in 1 million—a level above human tolerance. Called Olfactron, its developer, American Systems, Inc., says device also can be used to detect leakage of hydrazine, nitrogen tetroxide, and other toxic propellants. Instrument reportedly will be used at *Titan II* bases.

SPACE . . . IMAGINATION . . . ENERGY



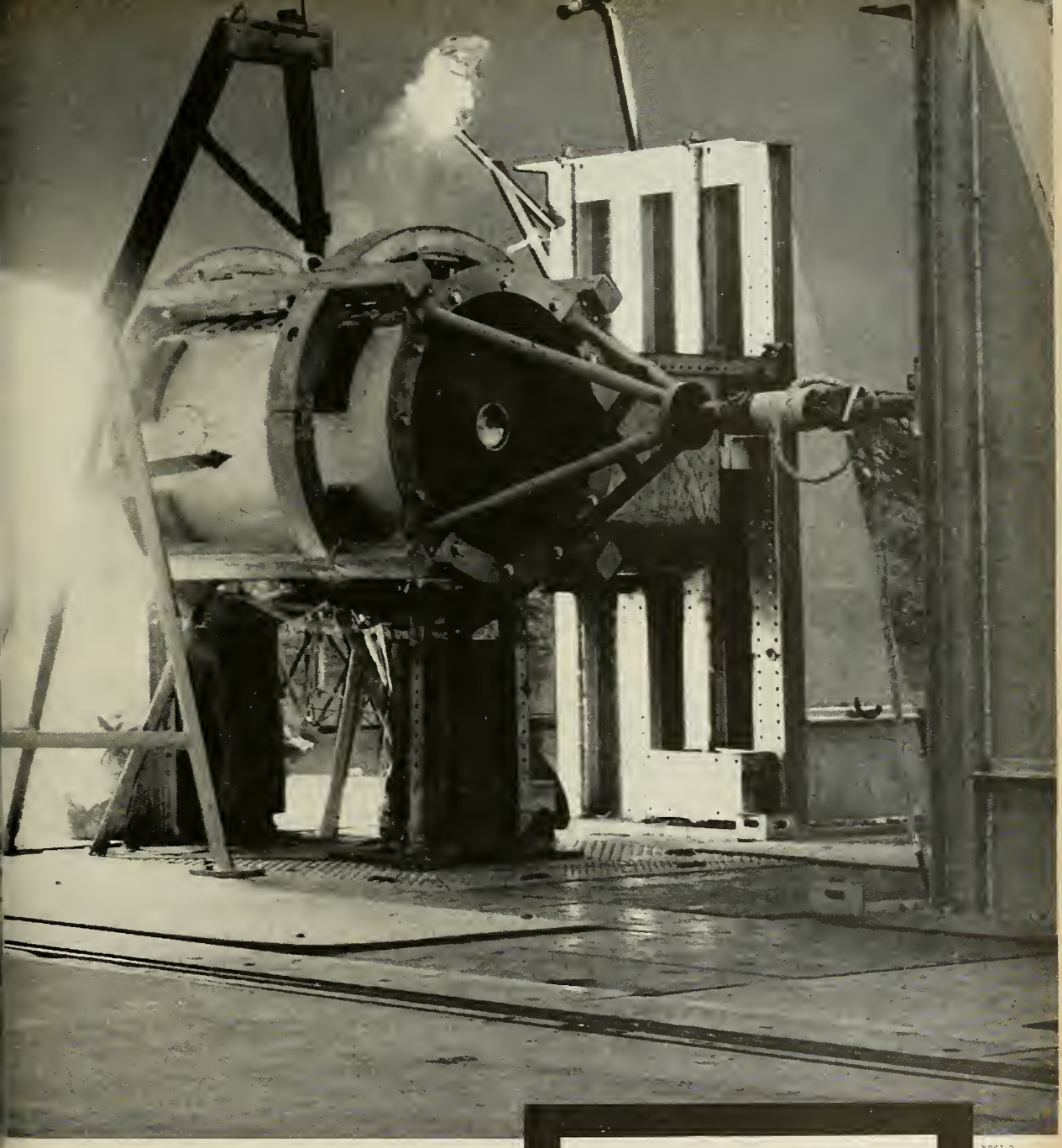


HERE'S HOW WE MEASURE MISSILE MUSCLE



This is one of the test-bays at the Hercules-owned-and-operated plant at Bacchus, Utah. Here the third-stage engine for the Minuteman rocket was developed and is manufactured for the Air Force. The advanced second-stage Polaris engine, developed for the Navy at Allegany Ballistics Laboratory, is also being manufactured here. Hercules' Bacchus plant is a fully integrated facility for research, development, and production line manufacture of high-specific-inpulse solid-fueled rocket engines.

As each new design-idea is proved out in roaring flame, a net of cunningly placed transducers take the engine's pulse, its temperatures, check its pressures, stresses and thrusts. This welter of information is fed, at 20,000 bits



per second over 240 separate input channels, to a central data acquisition room where it is permanently recorded on synchronized magnetic tapes. Meanwhile, as many as twelve high-speed cameras exposing up to 3,000 frames a second on a quarter-mile of film, keep a visual record of everything that happens with thousandths-of-a-second accuracy.

Thus, each test of component, propulsion unit, experimental design or completed engine yields a maximum amount of information ready for computer analysis and integration to advance both design criteria and manufacturing methodology. This is just another example of Hercules imagination in propulsion engineering.

XP61-2



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DYNA-SOAR



APOLLO CONCEPT



AEROSPACE PLANE CONCEPT

by James Baar

MAN IN SPACE

The Nation Needs to be Told Why It Should Invest Men and Vast Wealth in Reaching To the Moon and Beyond—The Best Case May be Made on A Stark Basis of Survival

THE BASIC space question before President Kennedy and the nation is why the United States should send men into space and to the moon.

Many officials, scientists and industrialists feel that U.S. space programs will continue to flounder until that question is convincingly answered and the answer transformed into national policy and goals.

Essentially, there are three main reasons why the United States might want to send men into space and to the moon:

The first is for science—and the possible resulting commercial and human gain.

The second is for Cold War prestige.

The third is for military security.

All are interrelated. All are questioned by one expert or another and one group or another. But only the third—military security—carries with it a mandate of absolute necessity if it is valid.

The yardstick by which each reason must be measured is the cost, in money, in time and in talent.

Estimates of the cost of placing men on the moon and bringing them back to earth have varied from $10 billion to $40 billion spread over the next six to eight years.

These figures are being argued over interminably. There are many variables, psychological biases, and complete unknowns. Personal ambitions and reputations are cranked into all calculations. Probably the only consensus that might be safely arrived at is that a space program aimed at putting men on the moon would be a very hungry consumer of tax dollars. Moreover, there would be a vast consumption of scientific and engineering talent and other resources. In brief, the total cost will be very high.

Rubbery as this yardstick might be, each of the main reasons for putting men into space must be measured by it. Nor is it impossible to do so.

• **Scientific**—Begin with science. There is much about the universe that scientists wish to learn in space. Space exploration already has extended the boundaries of human knowledge. And to take only one example, astronomers have contended that observations made from satellite-borne telescopes will give astronomy its greatest advance in hundreds of years.

As for applied science, communication and weather satellites are expected to prove to be multibillion-dollar boons to mankind. A satellite laboratory is expected to aid medical research.

However, these and other possible but still unknown gains can be achieved without man leaving the earth. From a scientific and applied scientific point of view, sending men into space is of questionable value.

• **Wherewithal?**—Also, it is extremely questionable politically whether any great enthusiasm can be engendered in the heart of the American taxpayer for spending billions of dollars in crash programs for the advancement of science—pure or applied.

Certainly, it has been most difficult to rally much support to spend billions of federal dollars in crash programs to build public schools, cure heart disease and cancer, or conduct basic research in hundreds of scientific fields.

Therefore, taken by itself, the value of "peaceful uses of space" as a means of obtaining large-scale fiscal support for putting men into space appears extremely small.

• **Image-making**—But "peaceful uses of space" must be taken into consideration with the second possible reason for a manned space program—prestige.

Since Oct. 4, 1957, Russia has used its space activities to harvest tremendous jackpots of propaganda. Before 1957, Russia was thought throughout much of the



LUNAR BASE CONCEPT developed by GE is predicated on theory that there is water under moon's crust. Artist's drawing shows nuclear power unit (left rear) which would be used to extract hydrogen and oxygen for life support and engine fuel.

world to be backward technologically and scientifically. *Sputnik I*, in the words of Madison Avenue, reversed this image.

The new image has been enlarged over the last four years, as Russia moved from space triumph to space triumph. America's continually lagging space efforts have done little more than corroborate the message beamed to the world by Moscow commissars in gray flannel suits. And U.S. prestige was further undermined by repeated denials from American officials that the United States was not in a space race while the United States continued to trot slowly.

However, it is not necessarily correct to deduce that the obvious course for the United States is to send men into space to counter Russian propaganda gains.

On the basis of prestige alone, the United States could buy far more lasting prestige by harnessing the H-bomb for commercial use; helping abolish famine by developing vast new sources of food in the sea; or eliminating disease. These also are the kinds of pay-envelope programs about which voters are traditionally more interested in hearing.

• **The big threat**—This leaves the third possible reason for a man in space program—military security.

From the night that news spread that *Sputnik I* had been launched many U.S. military men and space experts have looked upon the Russian space program as a one-track military effort directed at domination of space.

Over the last four years the Soviets have not disproved these prophets. Major step by major step, the Soviet space program has marched toward developing the capability of placing large military spacecraft in orbit and establishing military bases on the moon. Scientific gains that did not contribute to this program have been purely secondary.

As one top astronautics expert recently put it dryly:

"In spite of all official Soviet bows to science, and no doubt much genuine devotion on the part of individuals in the Soviet space effort, I would say that their effort is lead by strategists, not by scientists."

The direction of Soviet space efforts has by now become so obvious that official U.S. government apologists have been able to make claims that the United States is ahead of Russia in scientific exploration of space. As Russia has built bigger and bigger boosters and orbited manned spacecraft leading to military weapon systems, the United States has spent the bulk of its relatively small space budget on beating Russia in the collection of certain types of scientific data.

The result has been intermittent periods of public alarm usually quieted by soothing official statements from the White House and NASA.

Many top officials, including former President Eisenhower, have scoffed at the notion that there could be any military significance in the moon or the

Soviet space program. However, some of these scoffers have become quieter in the face of the Soviet Venus shot and the orbiting of Soviet Cosmonaut Gagarin. At the same time, many congressmen have made increasingly worried noises in public.

Unquestionably, the political climate for a greatly expanded U.S. space program has improved. But the goad clearly appears to be fears of Soviet military intentions in space—not Soviet scientific or propaganda gains.

So far, the White House has not indicated its appreciation of this. President Kennedy is still talking about prestige and scientific gain and then questioning whether "$20 billion or $40 billion" is too high a price to pay.

At the same time, all indications have pointed toward greatly increased money requests for NASA and far smaller ones for military programs.

• **Strictly R&D**—At present, there are only three man-in-space programs in being in the United States worthy of the name: NASA's *Mercury*, the AF-NASA *X-15* and the Air Force's *Dyna-Soar*. Everything else in this area is in the study stage or in somebody's head.

Here is the total funding for the three programs through FY '62: *Mercury*—$362 million; *X-15*—about $160 million; *Dyna-Soar*—$200 million.

All three are R&D programs. The *X-15* and *Dyna-Soar* are aimed at the development of military spacecraft capable of maneuverable re-entry and controlled landing. *Mercury* has the more limited goal of testing a man's reactions to orbital flight.

Beyond these programs, the Air Force has a wide range of studies such as *ASP*, an aero-space plane capable of internal rocket power fueled by the atmosphere; *Slomar*, aimed at developing manned and unmanned space logistics craft; *MTSS*, a military space station; and *Smart*, space maintenance and repair techniques. NASA has *Apollo*, a manned spacecraft designed to orbit the earth and later land on the moon.

Funding for such studies as these is usually under, rather than over, a million dollars each. For example, *GSS* (Global Surveillance System) studies is funded by the Air Force for a total of about $1 million, *ASP* about $2 million. *Apollo* is funded by NASA for some $750,000.

• **Booster doldrums** — Except for *ASP*, all of these studies are dependent on the development of large boosters—as *Mercury* has been dependent on *Redstone* and *Atlas*. However, to date only the 1.5-million-lb.-thrust *Saturn* is being pushed with urgency. All other big booster programs projects in the National Booster Program run by NASA are moving relatively slowly.

Meantime, Russia is already believed to have developed a booster in the *Saturn* class. One technically informed source has estimated that the booster used to orbit Gagarin and the *Vostok* spacecraft developed as much as 2 million pounds of thrust.

Also, some informed sources contend—and recent evidence clearly indicates—that the *Vostok* was winged like *Dyna-Soar*.

In any race for military domination in space the Russians are clearly well ahead even if some of the lowest estimates of Soviet capabilities are used. Using the higher estimates makes the prospects of overtaking the Russians discouragingly dark.

• **Fear and precedent**—Some military men fear that the first consequence of the Soviet military space lead will be the early destruction of U. S. reconnaissance and communication satellites. The next could well be the launching of Soviet orbital bombers.

To combat this threat, Air Force leaders have called for the development of manned offensive and defensive spacecraft. They stress the need for manning such craft in order to have the decision-making powers of a pilot rather than having to rely on machines.

This is the type of military challenge that Air Force Secretary Eugene Zuckert obviously had in mind last month when he told the Senate:

"The United States and the Free World must insure that the means of earth domination inherent in space mastery be not pre-empted by the enemies of freedom . . . The lesson is that through and from space, earth can be dominated."

There is much political precedent to show that the American public would support a vastly expensive man-in-space program to meet this kind of threat. There is little precedent that they would support it for any other reason.

However, it might be possible for Kennedy to use the fear created by this kind of threat to win support even for costly scientific man-in-space programs that would feed into more modestly-funded military programs.

The question then would be two-fold:

• How long would the American people support projects aimed at disguised goals?

• Could such projects, partly crippled by having confused goals, enable the United States to head off a Soviet military challenge in space? ⌗

'Best Answers' on Space Plans Are General

U.S. space programs have consistently suffered because of a lack of clearly defined goals.

In an attempt to pin down precisely where NASA hopes to go with its man-in-space program, M/R submitted the following questions to the agency and received the subsequent replies.

At no point can it be interpreted as offering much illumination either on the hard goals of current or future programs. Instead, the "best answers" as to NASA's program goals continue to be given in generalities. Meantime, Russia is driving to put a man on the moon by 1967.

The four questions:

Q: How many manned capsules do you plan to orbit under the present Mercury program?

A: NASA hopes to launch the first manned orbital flight before the end of 1961. The number and nature of subsequent manned orbital flights will depend on the results of the first manned orbital flight.

Q: On a shot-by-shot basis, what specific scientific experiments are being planned for each capsule? Please identify each shot by its approximate launch date.

A: The goals running through the manned flight program are (1) determination of man's stability to function during periods of weightlessness (2) to determine the psychological and physiological effects of space flight on man and (3) to advance space flight technology.

Q: What are the steps in-between the initial 3-orbit Mercury flight and the two-week Apollo trip? In particular, please detail how each intermediate experiment will build on your knowledge of how to support a man in space for long durations.

A: The steps between the three-orbit Mercury flight and the two-week Apollo flight are now under study. While a detailed answer to this question is not now available, NASA has said that it plans a multi-man earth-orbiting space laboratory between Mercury and the manned lunar missions.

Q: How much funding would NASA need to proceed with an R&D hardware contract for Apollo in FY '62?

A: The answer to this question . . . also is under review.

Hazards cited . . .

Science Takes Dim View of Man In Space

Bulk of scientists say the risks and costs are too high and knowledge to be gained is limited in value—but M-I-S is not without proponents

IF U.S. military posture and prestige were not involved, there probably would be no man-in-space project.

Indeed, the great weight of scientific opinion that has influenced government decisions on space spending has for years favored instruments over man. Even here, this country has lagged.

The U.S.'s late start in astronautics can be traced no further back than to 1956 when, apparently, a formal program of military satellite development began in the Air Force. Germany had started its astronautics program during World War II, and the Soviet Union in 1949.

The U.S. reluctance to send men into space was vocalized last year by former President Eisenhower, who—undoubtedly on the advice of his scientific consultant, Dr. George B. Kistiakowsky—severely questioned a follow-on to *Mercury* and gave only minimal funds to *Apollo*.

The reasons given for scientists' opposition to man-in-space are that it is costly, hazardous, and of relatively doubtful scientific value.

• **A waste of money**—Many scientists do not want science to be the scapegoat for what they believe will be an expensive experiment yielding very little. They claim that the money could be far better spent on more earthy projects.

For example, Dr. Vannevar Bush, a director of the Manhattan Project during World War II and therefore familiar with exotic and big-money research, says, "Suppose it would cost $1 billion to put a man on the moon. For the same money you could support a hundred research projects for 40 years. We need more basic research in physics, chemistry and biology. We need to finish the job of handling arthritis. We need to know more about the genetics of viruses."

Bush advises us to spend the money on projects such as these rather than on the present plan of "shooting it into space."

• **The "pro" view**—Many of those who want man to go into space for scientific reasons do not believe there's an "either-or" choice in spending the money—for instance, a choice between research seeking a cure of cancer or seeking the origin of the moon's craters. They say that in reality the choice would be between studying the moon or building B-70's or developing nuclear-powered aircraft or even constructing highways—that the money would never find its way into cancer research.

Moreover, they continue, by sending man into space we can move ahead in science and technology faster than by any other means, because we will have brand new environments to work with. It follows that where there are new environments there are also new and significant discoveries to be made.

At this point, a distinction is usually made between the work of unmanned probes and manned space craft.

An eager spokesman for manned space flight, Leo Steg, head of GE's Space Sciences Laboratory in Philadelphia, says that unmanned, measuring space probes should be sent to chart near space; but that the uncertainties of deep space call for intelligent beings rather than machines to do the exploring.

Steg points out that man is superior to machines in performing general experimentation, fabrication, maintenance, inspection, surveillance and piloting. Furthermore, he says, all these functions are basic to long-distance space flight to the moon and beyond.

On the other hand, the probe has the advantage in the areas of servo-function, sensing, and processes involving vigilance and speed, and perhaps even in decision-making.

Yet, Steg finds that man can outperform probes in the areas of manipulation combined with locomotion, pattern and object recognition, diagnosis and mode switching. Man also has the general attributes of self-programing, flexibility, adaptability and graceful degradation difficult to match with a machine.

• **The dismal science**—The problem can be looked at simply as one of economics. Speaking for this school, Rocketdyne scientist George P. Sutton told an aerospace medical meeting recently that man will be included in a space system if it is the most economical way to accomplish the mission.

He explained that ". . . system reliability must be improved or the flexibility of the mission must be sufficiently enhanced to make alternate ways of doing this mission without man considerably more expensive."

Observing that it is too early to reach a conclusion about extended future space operations, Sutton says that his personal feeling is that the number of missions that man will conduct as an operator will be relatively very few for the next 15 years. He gives the following reasons, several of which are being picked up by scientists who argue that man should not go into space now:

—For extended future manned space operations, we need a new big booster to give us the ability to carry the necessary payload for long-duration, long-

(Continued on pg. 38)

New Route to Cathay—Step by Step



Ralph S. Cooper of Los Alamos Scientific Laboratory has brought to the attention of the missile/space industry an interesting document.

The historic paper, with Mr. Cooper's comments, was reproduced in the form of an office memorandum on the subject of "Scientific Review Committees."

While it is well known that Columbus made a vain appeal to the senate of his native state of Genoa (as well as to the King of Portugal, to Henry III of England, and to the Dukes of Medina Sedonia and Medina Celi), it was not until very recently that the full official Genoan Senate reply came to light. It was discovered, along with other of his early documents and letters, in a monastery library in southeastern Spain and perhaps sheds some light upon why Spain rather than Italy was the dominant maritime and colonial power in the 16th century. A translation of the letter follows.

To : Cristobal Columbo
From: The Senate of Genoa

We the Senate of Genoa thank you, dear countryman, sea captain, geographer, and adventurer, for your presentation before us of an ambitious plan to open a new sea route to Cathay. Being most impressed, but untutored in the technical arts, we assembled a committee of the finest academic minds in our own and neighboring states to examine and review your proposal and make recommendations upon our course of action. We are most pleased with their intellectual insight and broad understanding of the problem.

Sig. Alfonso Chioggia, Physical Metaphysician, Genoa State University (GSU)

> "We must first study the oceans, their depths, temperatures, currents, tides, wind velocities, weather, and most particularly the recently discovered inner and outer dragon belts, and, of course, the effect of the edge of the world upon all the previous items."

Dr. Vittoria C. Vincenzo, Chairman, Department of Mechanical Arts, Venice Institute of Technology (VIT)

> "Vehicle and propulsion systems should be examined and the optimum selected for the mission. A careful comparison must be made of manned oar vs. sail propulsion and thought given to the development of advanced concepts such as might be based upon Hero's water vapour engine or Archimedes' screw. As for the vehicle itself, in addition to the many structural and hydrodynamic calculations, one must weigh the use of a single large ship against the suggested three of standard size."

Sig. Carlos Fiorento, Professor of Astrology and Occult Science, University of Genoa at La Spezia (UGLS)

> "One must develop techniques of astrogation, that is, selecting one's course by consultation with the stars and planets. Alternatively, one might consider using the newly developed lodestone, though this suffers from unreliability, inaccuracies, and is yet untested under the expected environmental conditions. Arrangements should be made for communication among the vehicles or with the base, and work proceed with flags, lanterns, mirrors, and notes in bottles."

Herr Dr. Franz von Schulte, Professor at Large, Medicine and Life Science, The University of Leipzig, visiting the Genoese Bureau of Research (Savona)

> "Such a voyage requires considerable advance in our understanding and controlling the various humours which afflict the human body and spirit. One obvious case is the prevention or cure of scurvy. In general, one must determine sound dietary regimens and devise techniques to provide for the sanitary necessities over long periods at sea. These range from obtaining fresh water from salt to concocting a variety of interesting fish recipes. This latter brings us closer to problems of the spiritual humour, involving long periods of loneliness and/or mal de mer with the possibility of group dynamic interactions leading to mutiny, for example."

The committee included representatives from the church (Msgr. Donella), the government (Minister De Stortzo), and the Bureau of Finance (Sig. Barrata). These eminent gentlemen discoursed at great length upon the theological and political aspects of such a project, and Sig. Barrata most wisely pointed out that one must compare the development and operational costs of this uncertain method of reaching Cathay with cost of improving the well-established Polo overland route. Indeed, he observed that one could pave the entire route with Florentine tile for the price of one round trip sea voyage. Nevertheless, these are prosperous times and the enthusiasm of the scientific members of the committee was undampened. Thus their recommendations were as follows:

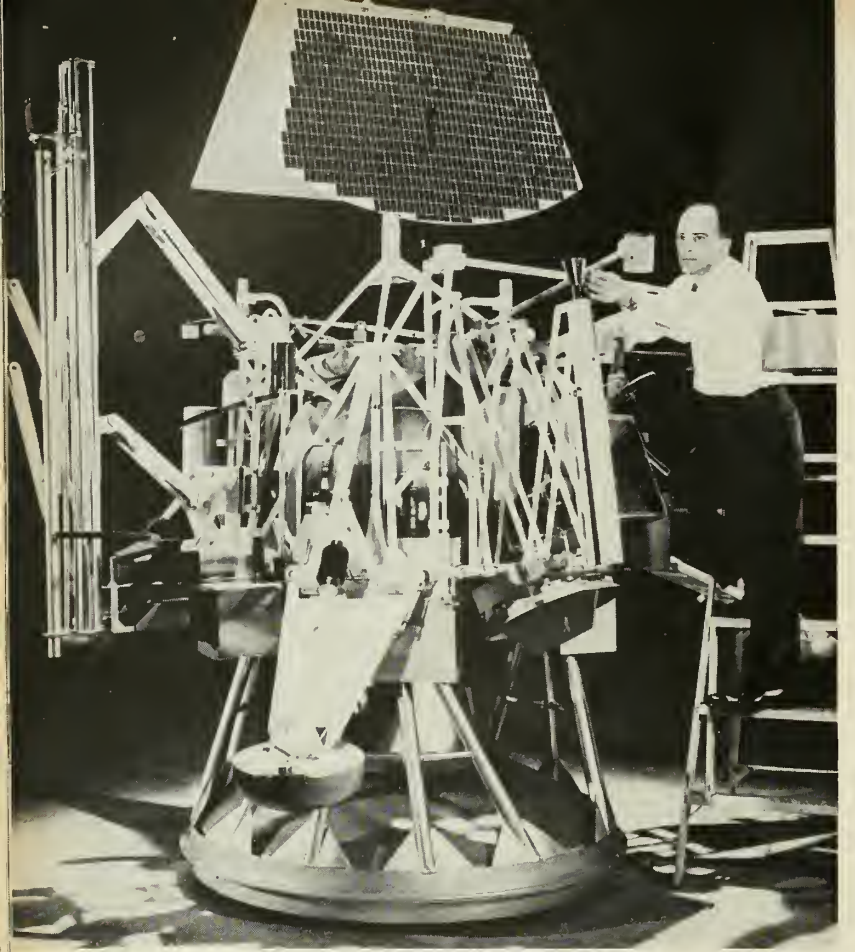
1. Study programs be initiated to solve the aforementioned problems.
2. When they are solved, a series of unmanned, instrumented vehicles be sent to Cathay, the final ones carrying animals and instructions for setting them upon the return route.
3. Finally, establish an academy for instructing captains in creative leadership (because, though you have conceived the trip, you are unikely to possess that exact mixture of attributes required for this demanding position) and for training crews in favorable dynamic group response.

We feel you will be quite pleased with the output of this progressive, forward looking committee of profound scholars. Incidentally, there was one additional member of the committee, a rather rash and impetuous young mechanical engineer, lately of Florence, who was sent in place of the ailing Dr. Taglatti of the University of Milan. Though he came highly recommended, he showed his immaturity and poor judgment by advocating the voyage itself be initiated immediately. Investigation proved him to be quite eccentric (he talks of flying machines and fancies himself an artist), and he was therefore dismissed from the committee. He is the illegitimate son of a Florentine notary and takes his name from the pace of his birth, Vinci, Leonardo being his given name, should you desire to contact him.

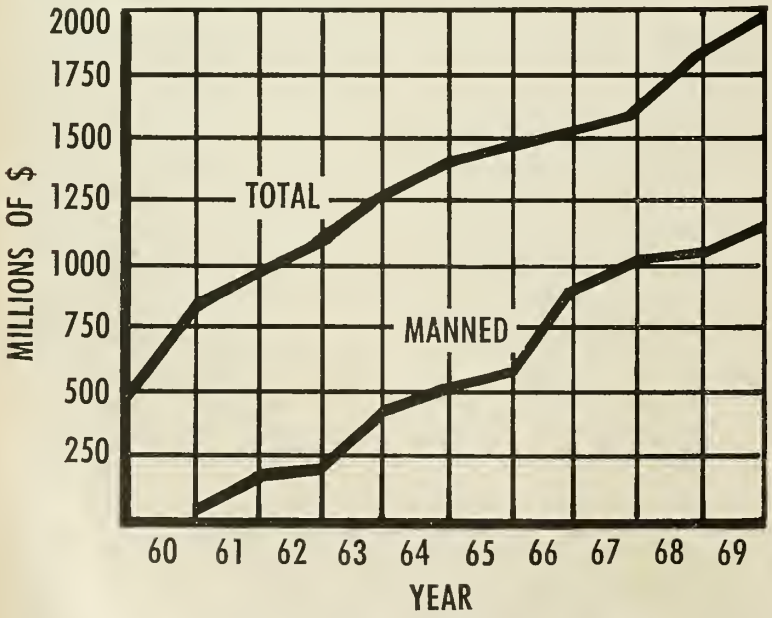
Most respectfuly yours,
Salvatore Paello
Secretary of the Senate
The Sovereign State of Genoa

Thus Columbus continued in his search for a sponsor until he was at last successful, at least in starting his voyage. It had been pointed out that the problem of trade with China (especially for Spain) is yet to be solved. Should another Columbus appear, what would we say to him?

Ralph S. Cooper



SURVEYOR 750-lb. soft-landing spacecraft, sometimes called a "mechanical octopus," will be crude substitute for man in early lunar exploration.



TOTAL MARKET for space payloads by 1970 will reach $2 billion, two-thirds of which will go for manned spacecraft, according to GE estimate.

(Continued from page 36)

distance missions.

—We need a lightweight nuclear-reactor-type power source which is shielded for manned space operations.

—We need experience in sustaining man in the hostile environment of space.

—We need a good microwave long-distance communications system.

—Furthermore, we need to know the results of many of the space programs now going on.

• **Man not ready for space**—One of the most outspoken critics of the course of science in the U.S. admits that we must use scientific achievement as a prime means for competing with the Soviet Union. However, Alvin M. Weinberg, director of Oak Ridge National Laboratory, asks whether the U.S. is wise in choosing manned flight into space as the primary event in these "Scientific Olympic Games." He objects to this policy on three grounds: hazard, expense and relevance.

Weinberg maintains that measurements of solar flare radiation, and perhaps of Van Allen belt radiation, are uncertain by a factor of ten (see p. 49). Furthermore, he says, various criteria now being used to calculate the thickness of radiation shielding may be considerably in error; and still further, the biological effects of the impingements of extremely energetic particles are not sufficiently understood.

Thus, although space is not clearly a forbidden land, it may be more hostile to human adventurers than it was believed to be five years ago.

Noting that we cannot really set the cost of a round trip to the moon, Weinberg says that ". . . the estimates of $20 billion to $40 billion for this mission are so large and cover so wide a range as to make the outsider doubt their validity on *a priori* grounds."

He cites the painful fact that bigness and high cost alone do not guarantee a project's success. For example, ten years ago leaders of the Lexington Project predicted that the nuclear-powered aircraft would cost $1 billion and take ten years to produce. The cost estimate was correct. But ten years later, no such airplane is flying.

Weinberg also warns against seeking after grandiose accomplishments which have little to do with the real issues of well-being. He points out that frequently in history the economic distortions caused by pursuing such goals have contributed to the decline of civilizations.

Nevertheless, it is clear that regardless of the debate man will be increasingly sent into space. It seems equally clear that the scientific reasons for sending him there may not be the most pressing ones. ⌗

Booster Ideas Are Big and Varied

Host of proposals is marked by spectacular claims by solid makers—combinations seen likely

by Frank G. McGuire

Los Angeles—If U.S. efforts to get man into space on a permanent basis rather than a hit-and-run basis should lag, it won't be for lack of ideas.

The current rash of booster proposals, concepts and combinations emanating from every propulsion company in the business recently prompted one harried recipient to mutter: "If paper could fly, we'd be so far ahead of the Russians, they'd go back to troikas!"

Despite the superabundance of ideas, however, there appears to be an uncomfortable feeling that this nation will do exactly what it did between 1955 and 1957—allow a perfectly capable launch system (in that case, *Jupiter-C*) to sit idle because nobody in authority will believe what it can do.

Rocketdyne says: "We had a 405,000-lb.-thrust liquid rocket system (the *Navaho* booster) around here for years, and nobody pushed it into our space program."

Thiokol says: "We've got *Minuteman* first-stage motors already produced that can put a U.S. manned vehicle into space with 1.2 million lbs. of thrust . . . But somebody will have to say 'Go!' "

Aerojet says: "This country has always underestimated what its industry can do in ten years, and overestimated what it could do immediately."

United Technology says: "Our biggest single deficiency is in large booster systems, and solid propellants could remedy this quickly if a go-ahead were given."

Almost without exception, propulsion engineers and their companies had similar comments on the U.S. future man-in-space program and the boosters it will almost certainly need.

• **Liquids vs. solids**—While liquid rocket proponents and many government officials dismiss solid-rocketry's claims as so much exaggerated wishful thinking, the solid-rocket advocates are chomping at the bit to get into the fray. They insist they can get large payloads into space cheaply and soon. Their major complaint is that "no one listens."

There may be a break in the offing.

In the eyes of presumably objective planners charged with advising the government on its future goals and systems for reaching these goals, the boosters of the next decade will very likely be combinations of liquids and solids, with the liquid stages uppermost.

Arguments for using solid rockets in the first, and possibly second, stages include economy, reliability, and the fact that maximum theoretical performance is not needed. Liquid rockets in upper stages will take advantage of highest possible performance with advanced propellants, where it counts most.

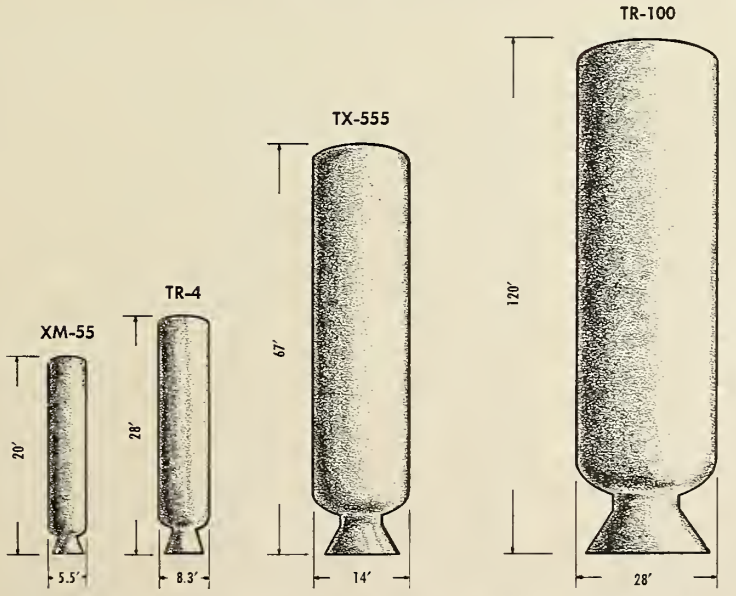
Nuclear rockets are seen only dimly—at a distance—for upper stages.

Electrical propulsion was described as "nothing to get operationally excited about until after 1970."

In citing advantages of liquids, Rocketdyne noted high performance, long duration, manned reliability, malfunction safety circuits, preflight checkout, hold down, clustering, recovery and re-use, cost. Simultaneously, the company named only manned reliability, clustering and cost as advantages enjoyed by solids when applied to large space boosters.

Solid propellant experts charged headlong into claims of high reliability for liquid boosters, saying such claimed statistical numbers as 99% + for liquid rocket reliability are interesting exercises in statistics, but just don't make sense when compared with the ratio of liquid-booster launches versus mission successes.

NASA interest in large solid boosters is high, despite the apparent disparity in a $68 million budget for liquid-fuel research and $3 million for solids. Maj. Gen. Don R. Ostrander, Director of Launch Vehicle Programs for NASA, said he would like to see about $15 million more devoted to



THIOKOL DESIGNS range from XM-55 Minuteman engine to 4.5 million-lb TR-100

each type of propulsion research.

Whatever the outcome of the solid/liquid debate, reliability, cost and performance are interrelated. Sporadic crash programs will not improve all three simultaneously.

• **Present programs**—In the present situation, *Mercury* is the best known example of manned booster systems. Used alone, the *Atlas* will put the one-man capsule into a 120-mile-high orbit for a short period.

With *Agena-B* added as an upper stage, *Atlas* will put a three-man *Apollo* capsule in a 300-mile-high orbit for longer periods. *Saturn* could put the same capsule on a circumlunar trajectory, using the *S IV* and *S V (Centaur)* upper stages.

NASA hopes development of the *Atlas-Centaur* vehicle will give the U.S. a standard launch vehicle which will be the heavyweight workhorse until availability of *Saturn,* when it will still remain as a medium-size workhorse.

Technical problems encountered with the *Centaur* vehicle, a two-engined design using liquid hydrogen and liquid oxygen, have caused NASA to postpone its initial flight test from mid-1961 to late 1961. The difficulty was in the hydrogen technologies involved.

One configuration which no one, especially the Air Force, wants to talk about is *Titan II* and *Centaur*. Both have a ten-foot diameter, and the combination would give the U.S. a capability to duplicate the Soviet Venus shot of February 12.

The Air Force has reportedly slacked off on *Titan II* information because of its big effort to "sell" *Minuteman* to Congress and the public. However, a space application for the *Titan II/Centaur* mating would bring many currently unattainable space goals within reach.

Many informed sources active in Air Force planning feel that *Titan II/Centaur* definitely has a place in a booster program, to fit between the capabilities of *Atlas* with upper stages, and the *Saturn* series.

Following the *Atlas Mercury* system, an *Atlas Agena-B* booster could put a minimum-mission two-man capsule into high orbit for two days or so. A *Titan II/Centaur* booster would put the same capsule into a higher orbit, or a better-equipped capsule into the same orbit for a longer time.

A very tight rein is being held on details of the *Titan II/Centaur* capabilities, but basic orbital missions can be speculated upon with available information. *Atlas Centaur* reportedly can put 8500 lbs. into orbit.

Based on unofficial guesstimates, *Titan II/Centaur* seems capable of placing at least 15,000 lbs. into a nominal 300-mile orbit. Considering the 2400-lb. weight of the *Mercury* capsule, the potential usefulness of a 15,000-lb. manned satellite appears worth the booster vehicle development.

The weight of a vehicle increases, according to the rule of thumb, with the increase in sophistication of re-entry methods. Air Force requirement for a 30-50,000-lb. payload for the *Aerospace Plane* project probably reflects this rule of thumb, and it is conceivable that a *Titan II/Centaur* payload would also use much of its added weight for a more sophisticated re-entry technique.

The same guesstimates give *Titan II/Centaur* a 2500-lb.-plus payload weight capability for escape velocities, versus the 1450-lb. capability of *Atlas Centaur* vehicles. A major reason for the added weight-lifting ability of the three-stage *Titan II/Centaur* is the considerable first-stage thrust increase over both *Atlas* and *Titan I*—namely, over 500,000 lbs.—plus the high impulse of *Centaur's* LOX/hydrogen propellants.

Although the *Saturn* program has been one of the major U.S. hopes in the booster race, there is a possibility—though not a probability—that it can be uprated even further by replacing the four center H-1 engines with a single F-1 engine. This change, including Rocketdyne H-2 engines rated at well over 200,000 lbs. thrust instead of the H-1's 188,000 lbs., would make the *Saturn* a 2.5-million-lb.-thrust vehicle. The single F-1 would be either fixed or gimballed.

Rocketdyne officials doubt that the step will be taken, but they say it is one of many being considered as an intermediate measure to the mythical *Nova* vehicle—which exists only as a concept to be powered by the F-1.

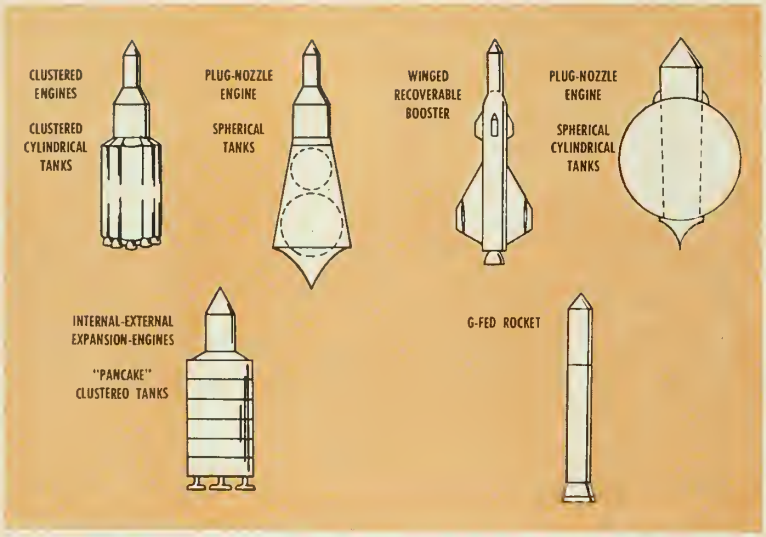
Rocketdyne says it will begin testing the complete F-1 assembly this summer, instead of the previously reported April, 1961, firings. The company expects to finish the PFRT (preliminary flight rating tests) by October of next year, and qualifying tests will man-rate it for use. Manned crews could use the powerplant anytime in 1963, a company official said.

Paul R. Vogt, Chief Engineer of Liquid Propulsion Operations at the North American Aviation division, said Rocketdyne will not use the F-1 in a single-engined application, unless NASA changes current planning. Many of the F-1's features, Vogt said, were developed with the never-flown E-1 engine of 400,000 lbs. thrust, product of a study program. He added that some of the tests even used E-1 parts.

Vogt also said Rocketdyne is working on an idea for using its J-2 LOX/hydrogen engine as a first stage, in addition to its normal upper-stage application for *Saturn*. Appropriate modification of the engine would adapt it to sea-level operation, possibly for a single-stage-to-orbit mission.

A cluster of J-2 engines, each developing 200,000 lbs. of thrust, is a "distinct possibility" for the future, Vogt said. No more than eight engines in such a cluster would be expected, he added, and he indicated possible use of an F-1 as an upper stage for such a high-impulse booster. The F-1 would, in this case, be modified from its present 14:1 nozzle ratio.

Commenting on the liquid/solid rocket debate, Vogt said: "Most major jobs in the future will be done by liquid



AEROJET study indicated these liquid configurations may be used in next 20 years.

rockets, while solids will retain their role in lower performance applications such as the *Mercury* escape system and retro rockets. That's the way things have been, and that's the way they will remain."

"Solid rockets will be able to improve their mass fractions only by the development of new materials," he added, "but these new materials will also apply to liquids, so there will be no ultimate change in relative performance, since mass fraction advantages are now with liquids. Solid-rocket boosters are currently 30% heavier than liquids for a comparable mission."

While going along with the liquid rocket's claim to higher performance, solid-rocket producers were inclined to give it little else—especially when manned applications were considered—and even predicted the gap would close.

Aerojet's Dr. E. R. Roberts sees solid propellants with specific impulse values of 265 seconds, capable of obtaining theoretical burnout velocities of 25,600 ft./sec. He said this would represent a 44.5% improvement over the most advanced versions of solid rockets now under development.

• **No breakthrough**—These improvements, predicted for 1965 or sooner, are expected to result from the natural growth potential of presently used materials and techniques, rather than a technological breakthrough.

The company feels that the polyurethane propellants slated for the large segmented boosters have been thoroughly proven in *Polaris*, *Skybolt*, and *Minuteman* second stage, and that quality control and inspection procedures are already established.

Aerojet says none of the presently considered future high-impulse propellants promises to be cheap enough for first-stage application, and that the polyurethanes will do the job more cheaply. With this in mind, the company feels 2½ to 3 million lbs. thrust is the maximum to be expected of a 140-in.-diameter solid booster. Clustering would be resorted to for larger thrust demands.

Thiokol's approach to the large solid booster situation is that of on-site-loaded solid-propellant motors, but only after the country has adequately exploited what it now has available—namely, *Minuteman* first-stage engines.

What's more, Thiokol says, the first flight test of a cluster of seven first-stage *Minuteman* engines (XM-55) can be conducted at Cape Canaveral within nine months from date project initiation.

The company has thoroughly researched the proposed vehicle and has no doubt concerning its feasibility.

The XM-55, clustered in a seven-motor first stage, would be used with a *Titan II* as upper stages to place a total of 25,000 lbs. into orbit. The XM-55's estimated ten million-lb./sec. total impulse would thus give a 1.2-million-lb. total thrust level to the cluster, and *Titan II's* engines would add well over 500,000 lbs. thrust after separation.

Thiokol believes the XM-55 has proven itself reliable, and that its status as a production item eliminates further development costs. In addition, the company says, the engine's structural strength allows clustering simply and cheaply; facilities and equipment for handling already exist; and properly clustered motors could place in orbit three times the weight now possible with existing systems.

Between 3700 and 25,000 lbs. can be put in orbit at costs as low as $178 per lb., the firm says, and 1000 to 7000 lbs. can be accelerated to escape velocities at costs of $559 per lb. by using the clustered XM-55.

In addition to this configuration using *Minuteman* first-stage engines and a modified *Titan II*, Thiokol has a number of designs for large solid boosters to be used for manned vehicles.

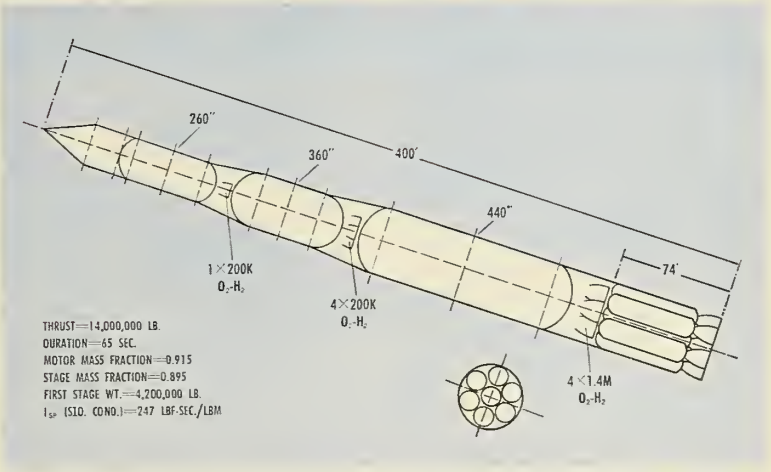
A solid-propellant "TR-4" design using the segmented approach could be used for those applications beyond the ability of the XM-55, the firm says. This design is predicated on a single-segment engine of about 70,000 lbs. gross weight, which, when coupled with another similar segment, could orbit 10,000 to 70,000 lbs. Orbital capability could also be achieved, Thiokol says, by using an unsegmented engine of approximately 110,000 lbs. gross weight with liquid upper stages.

Following the TR-4 is a TX-555 design to provide for manned lunar landings with return capabilities. Used singly as a first stage, the TX-555 would put 48,000 lbs. in a 300-mile earth orbit. A cluster of seven such engines would, when used with three TX-555's as a second stage and liquid rockets for third and fourth stages, place 320,000 lbs. into orbit.

Costs per pound of payload for the mission would be $119.00.

The granddaddy of the Thiokol designs is the TR-100 engine, with a gross weight of 4.5 million lbs. Used singly as a first stage, the TR-100 would orbit 300,000 lbs. when selected liquid rockets form the upper stages.

Regarding its loading techniques, Thiokol says the possibility of having a useless rocket on a pad due to poor propellant quality is slight. The company pointed out that a five-foot-diameter void could be tolerated in the propellant in a large on-site-loaded solid booster with only a ten psi change in chamber pressure—not enough to cause trouble.



HUGE VEHICLE seen by Aerojet would combine solid booster, liquid upper stages.

United Technology Corp. is due to begin test firings of its conical segmented engine, the S-1, this summer, with a view toward supplying NASA with the design for solid boosters in future manned programs. The S-1, a single-segment motor generating 250,000 lbs. thrust, will provide a basic booster which could be used with a number of existing upper stages as a workhorse vehicle. UTC has run calculations on using the S-1 with the second and third *Minuteman* stages, and both *Polaris* stages for orbiting 1000-2000 lbs.

UTC says it can produce the S-1 at the rate of two per week, and the question of higher production rates will be faced when necessary.

The company says about twenty S-1 flight-weight motors would undergo tests in a PFRT program.

UTC feels the conical segmented design will eliminate the erosive burning problem, and give other advantages to a solid booster. ❖

Spacecraft Plans Are Still Cloudy

Both Apollo and Dyna-Soar are pushed, but decision on scientific vs. military emphasis is yet to come—Aerospace Plane is factor

FUMBLING policymakers once again appear to be letting the United States drift down a double garden path of confusion and diffusion—this time in the development of manned spacecraft.

In the absence of a clear-cut objective, the Kennedy Administration presently is encouraging duplicate man-in-space programs by the Air Force and NASA—neither of which seems to offer any immediate hope of overtaking Russia in the race for the moon or elsewhere.

The situation today is reminiscent of the confusion and duplication which attended the birth of the U.S. big-missile programs a half-dozen years ago.

On one hand, NASA is preparing to proceed with a follow-on to *Mercury*—the three-man *Apollo*—which is intended to 1) orbit the earth for two weeks in the 1965-66 time period; 2) perform a circumlunar flight two years later; and 3) land on the moon in 1969-70. (Some NASA officials believe that if *Apollo* is turned into a crash program, the lunar landing possibly could be speeded up to 1967.)

On the other hand, the Air Force is proceeding with *Dyna-Soar*—a one-man glider—which is supposed to make its first suborbital flight in 1963-64, and *Dyna-Soar II*, which is to make its first orbital flight in 1964-65, providing the program receives sufficient funding. The Air Force also has in its pocket proposals for *Aerospace Plane*—aimed at creating an air-space weapon system somewhere about 1970, depending on how urgently it is pushed.

Moreover, the Air Force has funded studies for a series of other manned craft—orbiting space stations, *Slomar* (a shuttle for logistics and maintenance of orbital craft) and manned reconnaissance vehicles—which, if they become programs, would effectively duplicate or overlap NASA's plans for *Apollo*.

• **Scientific vs. military**—When they are set side by side, the proposed civilian program appears to be a less versatile duplicate of the proposed military program. There seems to be little question that the military program could provide the hardware needed for scientific research. There is considerable doubt whether the civilian program could provide the hardware needed by the military.

The outstanding technical difference between the programs is that *Apollo* will have a *Mercury*-like ballistic-parachute configuration, while the *Dyna-Soar* and *Aerospace Plane* vehicles are to be winged.

NASA's *Apollo* is conceived strictly for scientific exploration in testament to the "peaceful" approach of the U.S. man-in-space effort. But as of the moment, strangely enough, *Dyna-Soar* also fits into the strictly "scientific" category. For it is classified as a R&D project only—a project which "could lead" to an orbital-bombing weapon system. If not, to merely a winged version of *Apollo*.

At present, there is perhaps some question whether it is easier to realize a ballistic craft than one with wings—particularly for entry to the atmosphere after cislunar flight. There are significant advantages and disadvantages to both approaches.

But these must be weighed against what the two systems should be expected to accomplish. Is the mission really to be strictly scientific, or is it in actuality military in nature? The evidence is that the threat in space is military; that this is the underlying reason for speeding up the man in space effort.

If the objective is military, is *Apollo* the best path to follow? Can it be converted readily into a weapon system? Or should the other avenue represented by *Aerospace Plane* be pursued overtly from the start?

These questions are at the heart of the current U.S. space policy muddle. They become even more difficult when examined in the light of whether the country has the ability to produce simultaneously *Apollo, Dyna-Soar* and *Aerospace Plane*—and still catch the Russians. Each is a multibillion-dollar project. Each must draw on the same reservoir of technical skill and industrial capability.

The danger of diluting the space program seems quite apparent when the Soviets are pursuing only one path, and they are ahead.

• **Aerospace Plane starting**—Although the Kennedy Administration is giving every indication of placing its lunar landing bets on *Apollo*, it may



APOLLO SPACECRAFT concept by GE includes abort rockets (visible on sides). Three-man capsule would be located in cylindrical mid-section of 15-ft. vehicle.

hedge them somewhat with *Aerospace Plane (ASP).*

The Air Force is understood to be pushing for a FY '62 downpayment of $30 million to get *ASP* moving. Some work already has been done out of applied research funds—enough so that the Air Force hopes to move more into the feasibility-study-contract stage in July. Major companies in the competition include Boeing Co., Convair-Astronautics, Douglas Aircraft Co., Lockheed Aircraft Corp., and Republic Aircraft Corp. They are heading up sizable industry teams (Convair, for example, is teamed with Marquardt Corp., the Rocketdyne Division of North American Aviation Corp. and Garrett Corp.).

Marquardt is believed to have spent some $10 million on development of a liquid air cycle engine under Air Force sponsorship for *ASP* application (M/R, May 22, p. 14) and General Electric Co. and Pratt & Whitney are also reported to be working on engines for the spacecraft.

Overall cost of bringing *ASP* to operational status is estimated at $3-$5 billion by 1970. A crash program might advance the date. But this seems unlikely, unless President Kennedy decides to expand the military role in space materially.

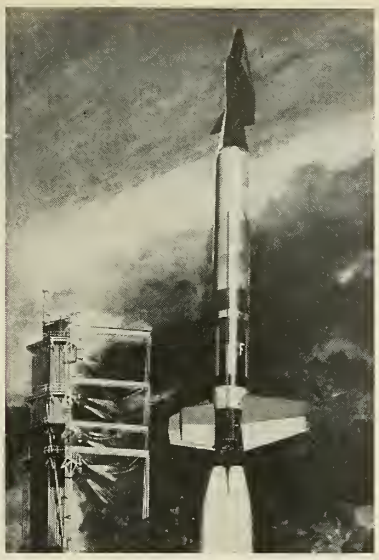
General specifications for *ASP* call for a craft which can take off from existing B-52 runways, accelerate to orbital speeds, rendezvous with space stations and return to the takeoff field for landing. It would thus provide the means for ferrying men and materials into space for construction of a spacecraft to be launched from orbit. Ultimate versions might make the *ASP* capable of earth-to-lunar missions alone.

Maj. Gen. O. J. Ritland, chief of the Air Force Systems Command Ballistic Missile Command, said recently there is no technical reason why *ASP* could not perform earth-to-orbit missions. He indicated no breakthroughs would be required. Marquardt likewise contends no major breakthroughs are needed in the engine area.

Presumably engines for *ASP* would be hybrid rocket-ramjet with the craft taking off on rocket power and accelerating to hypersonic speeds where the ramjets would take over. Under Marquardt's concept, the craft would then orbit through the earth's atmosphere, scooping up oxygen which would be liquified with the help of an in-board supply of liquid hydrogen and stored in tanks. Since this process would occur after takeoff, gross takeoff weight could be minimized.

On leaving the atmosphere for space, *ASP* would then revert to LOX-LH_2 powered rocket.

• **Dyna-Soar—bigger potential?—** *ASP* would be an outgrowth of the rocket-boosted *Dyna-Soar* glider. There is a question of how superior it would be to *Dyna-Soar* if the latter was designed in later models for in-board propulsion.



DYNA-SOAR, shown in artist's drawing atop Titan II, is to weigh about 5 tons.

Not much has been said about the potential of *Dyna-Soar.* Engineering details also are skimpy. *ASP* represents Air Force hopes for a one-unit spacecraft, eliminating boosters and having the advantage of a powered landing.

But *Dyna-Soar* is the only solidly-funded spacecraft beyond *Mercury* and it is the first U.S. attempt at putting wings on a spacecraft.

The possibility of *Dyna-Soar* becoming a rendezvous vehicle is apparent. Martin Co.'s concept of *Slomar* closely resembles configurations advanced for *Dyna-Soar.* The main difference is in *Slomar's* capacity for carrying five men, against *Dyna-Soar's* one.

This has important ramifications in the technique to be employed in accomplishing a moon mission. It also points up another area of potential overlap with *Apollo,* which also is being designed for orbital rendezvous.

Insufficient booster capacity probably will make it necessary to use an orbital launch for a flight to the moon. *Apollo* would need orbital refueling for a lunar landing and return, and although it has not disclosed any plans in this direction, presumably any lunar craft proposed by the Air Force would, too.

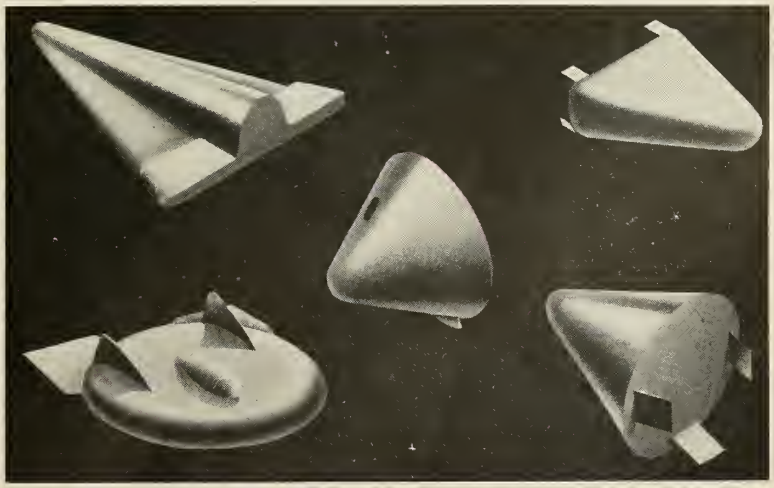
Dyna-Soar is expected to weigh in the neighborhood of about 10,000 lbs. —approximately 8000 lbs. for airframe and some 2000 lbs. for wings and supporting structure in its early configuration. The three-man *Apollo* would weigh 12,500 lbs., giving it a considerable weight advantage.

Designs made available by the Air Force show *Dyna-Soar* to be basically a single delta wing with a pair of vertical stabilizers at the outer edges. It will be about 35 ft. long and have a wingspan of about 20 ft.

• **Mating problems**—NASA's spacecraft specialists have calculated that the addition of glider-like wings to a reentry vehicle adds at least 30% to the weight. Besides the weight penalty, the winged vehicle develops serious problems of aerodynamic stability on the upward flight.

The Air Force already has decided that the *Titan* must sprout fins to take care of the stability problem. The *Saturn* will also have fins if it is used to propel the *Dyna-Soar* into orbit.

(Continued on page 106)



FIVE ORIGINAL PROPOSALS for Apollo configuration have reportedly been narrowed down to three at center and right. Weight penalties caused rejection of others.

Soviets went all-out . . .

Life Scientists Demand Top Priority

Experts warn that long-term manned missions can only be undertaken after much more is known—no program exists

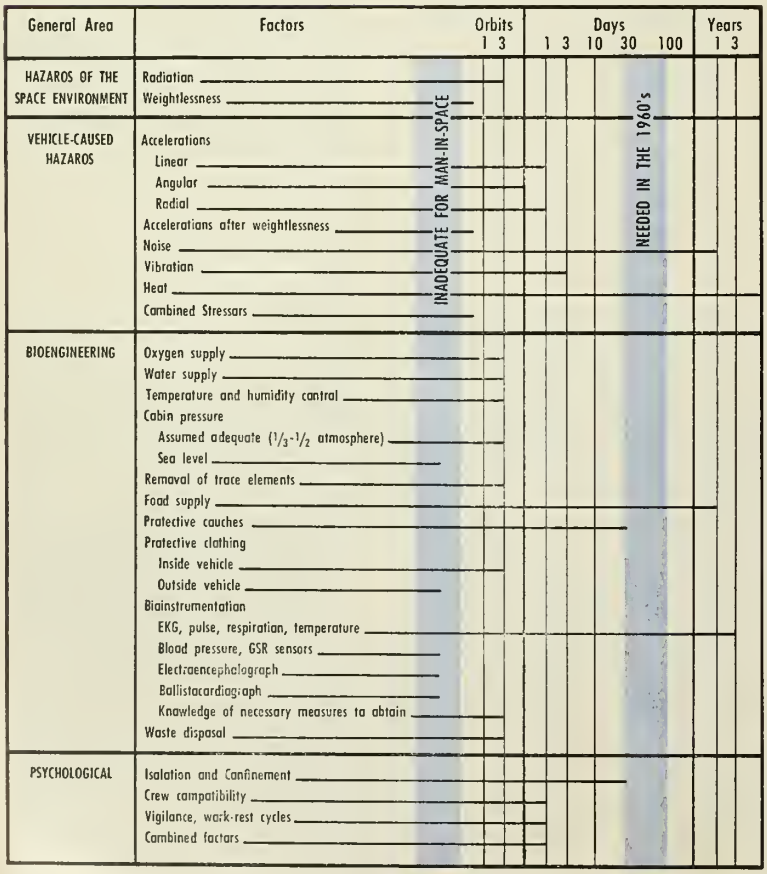
by Heather M. David

MAN, MOST IMPORTANT aspect of man-in-space, may be getting short-changed by an inadequate, directionless support effort.

In general, the problems are known. The medical profession knows what a man needs to stay alive; psychologists need a thorough knowledge of how much he can be asked to adjust and still live effectively.

Some compromises will have to be made. "Adjust," a true 20th century slogan, will be the byword of the spaceman of the decade. And for this we need a thorough knowledge of how much he can be asked to adjust and still live effectively.

There's a great deal to be done. Some of it can be done in ground laboratories. But as Dr. Robert S. Pogrund of the Aerospace Corp. told M/R: "What is needed is an assignment of highest priority to the biomedical space effort. We need well-controlled and well-designed biomedical experiments that produce clear-cut, interpretable results, in lieu of the previously designed piggy-back type of experiment."



CURRENT STATE OF KNOWLEDGE chart compiled by M/R shows that the United States must close some serious gaps in order to attain goals it has set for the decade.

• **Contrast in effort**—The Russians apparently saw this several years ago. The whole story of the Soviet space program is a straight line of biomedical flights. They built on each one, added information, and ended with a superior system containing a man. Apparently before 1957, a top-level decision was made that the national goal was a man in space. A realistic, all-out effort was made to attain it.

In America, it has so far been a different story. One U.S. life sciences expert recently said: "There is no existing program in the United States that aims at solving the future problems of manned space flight."

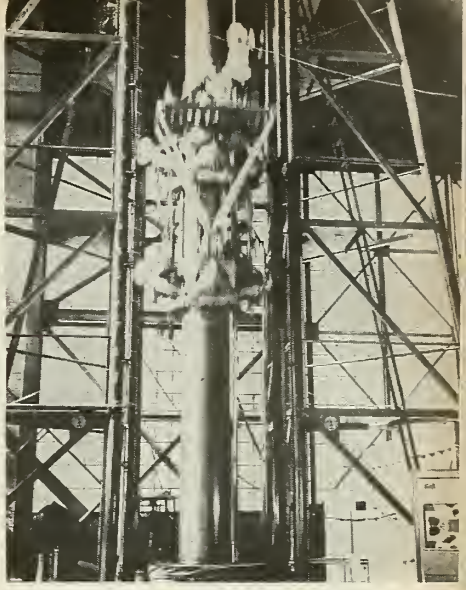
The present U.S. manned spaceflight schedule calls for *Mercury* orbital flights in late 1961 and 1962. The next announced step is an *Apollo* vehicle which might begin orbital flights in 1966 or 1967. The National Aeronautics and Space Administration has not announced any interim program beyond some orbital shots with chimpanzees in *Mercury* capsules.

A lot of space medicine people are warning that it may be foolhardy to construct a vehicle such as *Apollo* for long-term missions without first finding out exactly what is needed. These are the problems—puzzles which can't be solved in simulators, computers or by extrapolating from a few hours' experience:

—Longterm weightlessness—whether or not to design the ship to provide artificial g. "Let's not be caught in 1970 with all our money on one horse and



TRUE WEIGHTLESSNESS in an AF C-131 unfortunately last only half-minute, is preceded by a 2½-g dive plane must make to prepare for ballistic trajectory.



SHAKING experience tests subject's reactions during vertical accelerations.

find out it can't run the distance," critics say.

—Radiation—not what it measures on an emulsion pack or pieces of tissue, but what does it do to a whole animal?

—Spaceflight itself—there's literally no way on earth to combine all the physical stresses—even those caused by the vehicle alone. And there's no way to simulate the sheer terror that might afflict a space traveler.

The *Mercury* capsule is not considered particularly adaptable for use as an experimental animal space laboratory. Its life support system cannot be extended to supply oxygen, food and water for more than about two days without installing a completely different type of system. Only enough hydrogen peroxide for attitude control can be carried for a short mission.

The *X-15* and *Dyna-Soar* simply won't fly long enough.

The Air Force has proposed a bio-astronautical orbiting satellite system *(BOSS)* to orbit a 40-50 lb. chimpanzee for several weeks. Lockheed Aircraft has designed a mockup capsule which could be flown on an *Agena B*. The Garrett Corp. has engineered a very promising life support system which was shown at the Aerospace Medical Association's recent meeting in Chicago. But the program remains in limbo for lack of funds.

Col. Charles H. Roadman, acting director of life sciences at NASA, also admitted that an interim program of some sort would be necessary. But so far no one has gotten a franchise.

• **Experts restless**—Some harsh comments are being made in industry circles about the situation.

A spokesman for the Garrett Corp., recognized authorities on life support systems, told M/R: "Insufficient emphasis has so far been placed on the requirements of human occupancy for long-duration voyages."

He suggested, "A central government agency should be established to direct the life sciences and environmental control systems activities on the basis of national policy and objectives, with all of the various services facilities participating in combined complementing operations."

The Northrop Corp.: "A satisfactory approach to development of life support equipment has not been taken and indications are that, at present, this work lags badly."

The head of life sciences engineering department of one of the largest companies in the spacecraft business said: "The lead times for life support systems are much longer than for other systems and the present lack of effort is really going to hurt."

He added, "the amount of money budgeted for the life sciences does not reflect the stated objectives of the country."

At the Aerospace Medical Association meeting this year, there even was a movement to pass a resolution urging that "every available and competent scientist devote his full energies to solving problems involving manned spaceflight." Although the resolution was not acted on, the problem was recognized.

There's no lack of people who'd like to do the job. An estimate of the in-house effort in industry would have to run in the millions of dollars. There is considerable enthusiasm in all branches of the services for space medicine or life science projects.

The situation is producing some unnecessary duplication, which the Garrett Corp. terms "unnecessary, inefficient and uneconomical." Says Spacelabs vice president Jim Reeves, "This will continue until mission definition and assignment of responsibility have been carried out."

• **Radiation**—Urgently needed is a series of animal probes. These should be sent to different altitudes and orbited for varying lengths of time. Also, each experiment will have to be repeated to get data for both years of maximum and minimum solar activity. (See Special Report: Radiation, p. 49).

• **Weightlessness**—The question is "how long?"

U.S. space medicine experts suspect that weightlessness' effects can be divided into three categories: 1) short-term flight, up to three orbits—no problem. 2) flights lasting more than about six hours—some muscle debilitation which can be corrected with exercise. 3) flights longer than perhaps 10 days or two weeks—may require rotating the ship to provide artificial g.

The third point poses the challenge. When will it become necessary to rotate the ship? A good way to find the exact breaking point would be to perfect an animal satellite which could be orbited for a week or weeks at a time.

Current experience in weightlessness is practically nil: U.S.: Alan Shepard 5 minutes, *MR-3*. Major Robert White, 2 minutes, *X-15*. The *X-15* is capable of about 4 or 5 minutes by flying in a ballistic trajectory, the KC-135 about one minute, the C-131 half a minute.

The Soviets say that weightlessness during Gagarin's one-orbit flight had absolutely no effect on him. No scientific results have ever been published on

the Russian dogs which were weightless for a day or so in *Sputniks II, V, VI and VIII.*

There are two methods of simulating weightlessness, neither completely satisfactory. Suspension in water can produce some of the effects of muscle disuse and lack of stimuli. The Air Force's Aeromedical Laboratory is studying these effects at Wright-Patterson AFB (M/R, May 22, p. 36).

Chance Vought Astronautics has constructed an air jet-supported platform which attains a near-frictionless state. A man on the device has some of the same difficulties of moving about and functioning as in a weightless condition. Vought is using it to design tools for use in space vehicles.

Some extrapolations from ballistic trajectory flights may be useful if very-short-life animals are flown. Chance Vought has an Air Force contract to make cine-microscopic observation of amoeba launched into ballistic trajectories. General Electric's J. J. Konikoff has also suggested studying the interaction of enzymes in the short-term weightlessness, but the studies are mostly in the theoretical stage.

• **Accelerations**—*Mercury MR—3* proved that an astronaut could easily withstand the g forces of normal launch and re-entry. In fact, much higher stresses have been withstood in centrifuges and rocket sleds.

At one time a number of people had suggested that an astronaut could survive g forces better if he travelled in a "space bathtub." This idea has largely been dropped because of experiments on both the Navy's Johnsville and the Air Force's AML centrifuges. The men could move their arms and legs better, but trapped air in their lungs and around their hearts caused pain. Chimps given more g's died because of the trapped air.

Actually, the real problems are not in a normal trip but in impact and escape. Not much is known about how violent an impact a human can survive and how best to protect him. Physiologists at General Electric MSVD are literally "dropping mice" in the hopes of extrapolating some of the tolerance data (M/R, April 17, p. 35).

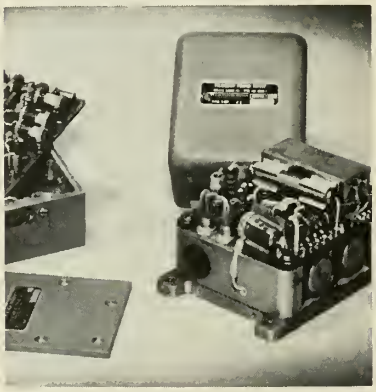
A Dayton firm, Technology, Inc., is delivering a vertical deceleration tower to the Aerospace Medical Lab at Wright-Patterson which should help fill in some of the gaps.

Emergency escape may be a pretty horrible experience. The pilot would be buffeted about, getting high g's from all different directions in succession.

Dr. Harold J. von Beckh, an Austrian scientist now at the Aeromedical Field Laboratory at Holloman AFB, has formulated what he calls "multi-



CONVAIR'S "space station" will duplicate space heat, isolation and vacuum.



TEXAS INSTRUMENTS' Mercury telemetry transmits data on pilot's condition.

directional g protection." The escape capsule would turn automatically—and quickly—so the pilot would always get the g in a transverse direction. He'd probably be a very sick boy but he'd have a better chance of staying alive.

Norair Division of the Northrop Corp. has designed a simulator especially for tumbling and spinning. (see cut, p. 73). The 10-ft. sphere will rotate on three axes up to 70 rpm—a real torture device. The School of Aviation Medicine will use it to investigate restraint systems and body positioning.

• **Heat, noise and vibration**—A very important study on thermal and atmospheric controls for space vehicles is being conducted by North American Aviation under a three-year, $1.5-million contract. Garrett's AiResearch division holds a $300,000 subcontract for the manned capsule portion. Results will undoubtedly influence future systems.

Doctors know a lot about how much heat, noise and vibration a man can stand. Much more simulator work is needed in combined stresses such as vibration + heat + noise, or better still vibration + heat + noise + acceleration. Dr. A. H. Schwichtenberg, Lovelace Foundation's Aerospace Medicine chief, said "We need a rocket sled 150 miles long—not just 7 miles."

A simulator being built for the Air Force by Garrett can combine low pressure, heat, noise and isolation, and can be placed on a centrifuge. Norair's rotational simulator also has temperature and pressure controls.

• **Bioengineering**—As the U.S. projects its goals to longer missions, it becomes more and more essential that a flight-worthy regenerative oxygen and water system be developed.

Exotic plant systems will probably remain in the textbooks until well into the 1970's. The early spaceman will get his oxygen from a chemical CO_2 cracking system or through electrolysis of water.

Space medicine experts evaluating reports of the Gagarin flight say that the Russians already have a superoxide regenerative oxygen system. An endless supply of oxygen could mean an astronaut's life if his re-entry system failed. Orbital decay would eventually bring him down, and he might live the extra week or so without food—but not without oxygen.

Also needed in the next few years is a regenerative water supply. General Electric has succeeded in reclaiming potable water from urine at a relatively low weight and power cost. The apparatus is now being tested at the Navy's Air Crew Equipment Laboratory.

Trace elements not even thought about on earth could be very dangerous in a few square feet of enclosed air. A number of laboratories are now investigating man's tolerance to minute amounts of these elements.

Bechman Instruments is developing a gas chromatograph which will be used on future NASA programs.

• **Cabin pressurization**—Man's natural environment is a two-gas atmosphere at near sea-level pressure. The best the U.S. has been able to provide for its space capsules is a one-gas system —100% oxygen at about ⅓ sea level pressure. Although this may be perfectly satisfactory for the *Mercury* astronaut, bioastronautics experts warn that it may be dangerous to ask a man to adjust too long.

A real breakthrough needed in the 1960's is the engineering of a two-gas system attaining sea-level pressure. Sophisticated sensors will be needed to sense each gas separately and maintain the proper balance. At the same time,

(Continued on page 92)



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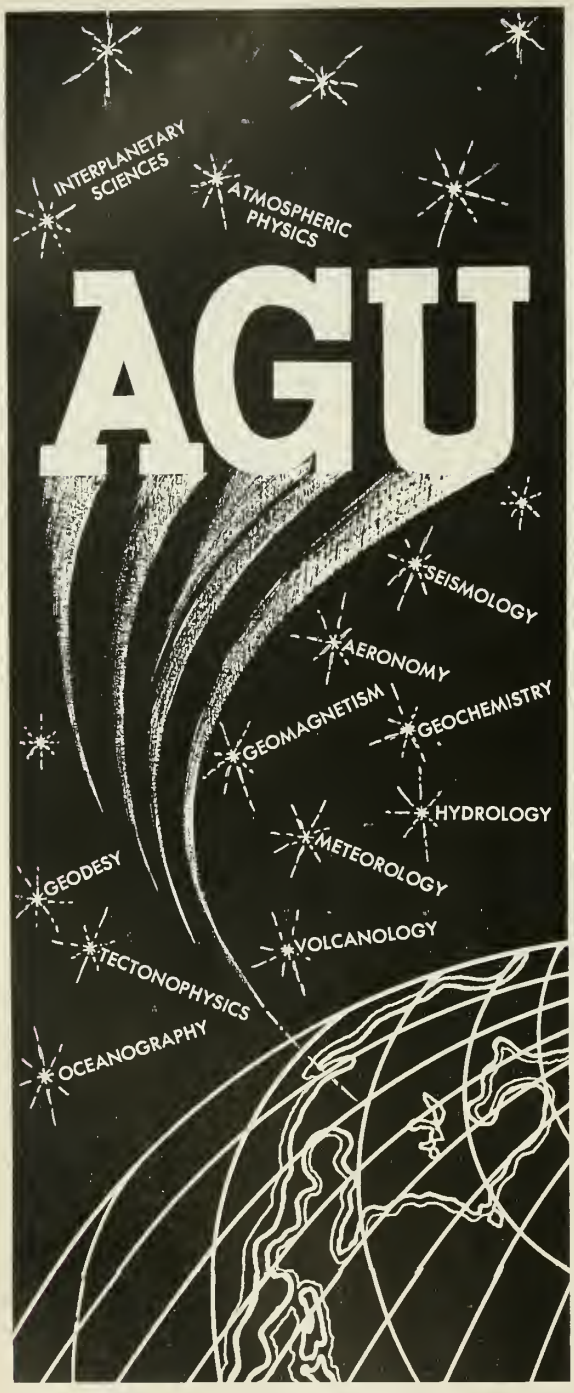
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Radiation Hazard Is Top Flight Problem

Little is yet known of how man and materials will wear under exposure—solar flare measurements highly unsure

by John F. Judge

THE LARGEST single problem facing man-in-space originates with the oldest body in our solar system—the sun.

As recently as 1958, radiation in space was thought to be negligible. In May of that year, Van Allen announced the discovery of the great radiation belts around the earth. Closely after this came the discovery of the solar proton beams or solar cosmic rays. Radiation then became a major factor affecting spacecraft configurations and weights, and the choice of trajectories.

Little is actually known, even now, about the nature of space radiation, although a great deal of data has been published in the past three years. But the ionizing radiation a vehicle encounters in space is known to consist of at least three types—cosmic, trapped and solar flare.

Cosmic radiation is currently thought to be of minor importance to structural designers. The dosage is expected to be quite small, and, in any event, cosmic rays comprise atomic nuclei traveling with such extreme velocities—corresponding to energies in the bev region—that no foreseeable shielding will stop them.

The best that can be hoped for is that passage through the vehicle will produce a minimum background dose level.

H. E. Newell and J. E. Naugle of NASA say one aspect of cosmic radiation has not been entirely evaluated. While the overall integrated dose is very small, a very intense exposure is given to a very small amount of material along the track of the individual particle as it stops. Experiments with high-altitude and -latitude balloon flights are continuing

A recent Air Force state-of-the-art report says that cosmic radiation is composed of about 79% protons, 20% alpha particles, 0.78% carbon, nitrogen and oxygen nuclei and 0.22% nuclei with atomic number greater than 10.

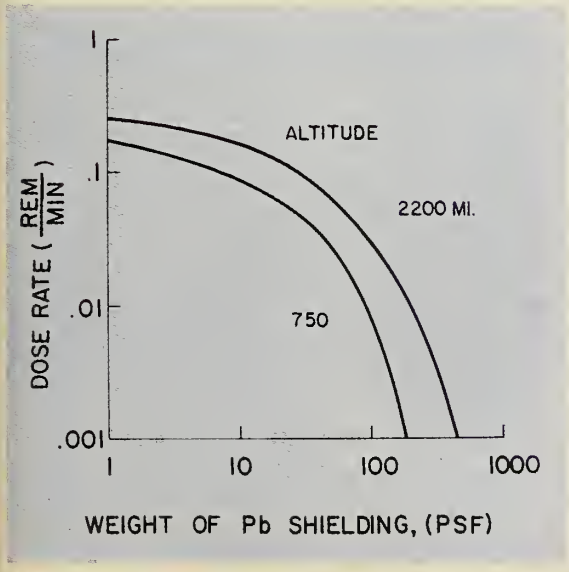
In addition to the particulate component, there are very-high-energy gamma rays. The total effect of passage through a material is secondary radiation composed of electrons, protons, neutrons, mesons and a variety of "strange" particles.

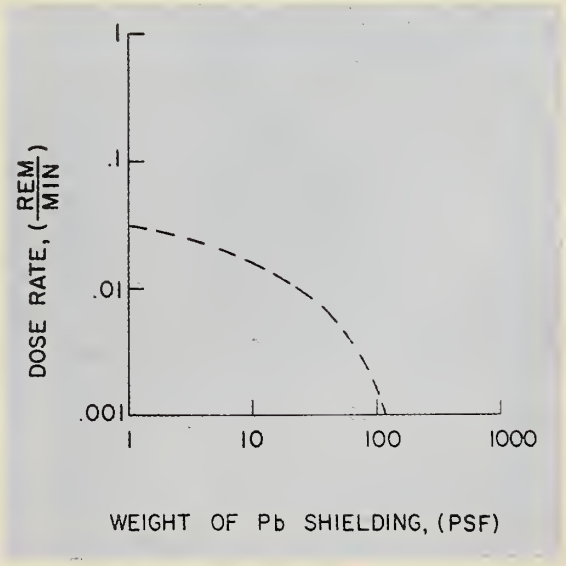
For man, the relatively small amount of high-atomic-number nuclei may be of extreme importance. No biological damage attributable to heavy cosmic-ray primaries has been found. The biological significance of the multi-pronged stars found in nuclear emulsions exposed at high altitudes is not known. But such stars resulting from the collision of very-high-energy particles with an atomic nucleus in living tissue must represent a very damaging microscopic explosion of energy.

• **Avoidance techniques**—The most thoroughly defined space radiation is the inner Van Allen belt, says Norris F. Dow, of General Electric's Space Science Laboratory.

The inner zone appears to be stable, showing little variation with solar activity. It is also characterized by the presence of high-energy protons. The outer zone fluctuates in radiation intensity and spatial extent. The fluctuations have been induced by solar activity.

Only a general estimate is possible with regard to tissue ionization dosage and penetration. The general rule





LEFT: *Minimum weight of shielding required in inner Van Allen belt to give indicated whole-body dose rates.* **RIGHT:** *Estimate of requirements during solar burst. Dashed curve is for order-of-magnitude purposes, since solar data is inadequate.*



MARTIN CO. SKETCH of Van Allen belts shows a space vehicle trajectory plotted to avoid the greater portion of the belts by escaping along a polar region.

adopted for manned space flight is that the Van Allen belts can be ignored to a great extent. Some authorities have suggested that man be launched in trajectories through the polar regions in order to avoid the belts.

Others have pointed out that this may not be necessary if the transit time through the belts is of a short duration. This probably will be demonstrated in the *Apollo* program.

On the other hand, if shielding must be provided against the possibility of intense solar flares on long missions, the shielding for the lower-energy Van Allen radiation will be automatically resolved. Even brief transit times through the intense band of protons should be avoided on a long mission, however, because the crew exposure is additive.

• **Space sunburn**—The major barrier to meaningful man-in-space missions is the sporadic contributions of the sun. Years of observation have led to the knowledge that the gross energy output of the sun is fairly constant. But the relatively minor variations that do occur make interplanetary space in the region of earth and its sister bodies a very unpleasant environment for man.

Luckily, the sudden bursts of energy from the sun arriving in the vicinity of the earth have been fairly well catalogued in recent years and apparently relate to the development and decay of a very small active area on the sun.

The most intense source of radiation encountered in space originates from the solar flare—a sudden, short-lived brightening of the solar surface in the neighborhood of a sun-spot.

A. D. Goedeke of Douglas Aircraft Co. points out that these sporadic events are very common. During the International Geophysical Year (July, 1957-December, 1958) a total of 6762 flares were actually observed.

Only a handful of these were connected with the arrival of protons in the vicinity of the earth. But these energetic clouds have increased the free-space cosmic ray counting rate by a factor of 1000. It is generally believed that this proton flux is omnidirectional in the earth's vicinity.

The frequency of the events varies over the 11-year cycle of solar activity. The current period is one of low activity. Unfortunately, the next period of high solar activity begins in 1967—approximately the time of the first extended *Apollo* missions.

• **Conditional data** — With respect to the effect of all ionizing radiation in space, Norris believes there is reason for optimism regarding the successful use of common structural materials, and reason for pessimism about the adequate protection of man.

In both cases, current knowledge is based on extrapolations. No significant amount of data exists on the combined effects of radiation and hard vacuum on materials. It is possible, especially for plastics, that the combined effects may be worse than radiation alone.

The radiation effects on metals are negligible. Structural plastics are considered more vulnerable, and damage may be expected in typical reinforced plastics when they have received doses equivalent to about 30 million rad. The most sensitive plastics are damaged by approximately a tenth of this.

Norris says that compared to the intensities existing in space even at the highest levels in the lower Van Allen Belts, the damage threshold values are so high that, evidently, materials could exist for many years without deterioration. But the electrons in space, while less penetrating than protons, may appreciably reduce the lifetime of external surface materials from these values.

With man in the picture, the situation is reversed. Man's relationship to radiation involves a consideration of a number of relative terms. For years X-ray dosages have been expressed in roentgens—which is an exposure dose defined by the production of 1 statcoulomb per cubic centimeter of air at standard temperature and pressure. Rads seem to be the more correct terminology when referring to man; one is defined as a unit of absorbed radiation equal to 100 ergs of energy absorbed per gram.

The Atomic Energy Commission uses the term rem (roentgen equivalent man), but there seems to be little agreement as to its efficacy. It was introduced to reduce the expression of doses from different types of radiation to a common basis, in order to permit addition. It is defined as a radiation dose of any ionizing radiation estimated to produce a biological effect equivalent to that produced by 1 roentgen of X-rays.

The dose in rems is equal to the dose in rads, or roengtens, multiplied by the relative biological effectiveness (RBE) of the radiation involved for the situation in question.

RBE is the experts' favorite term for describing the hazards to man in space. Loosely defined, it is proportional to the amount of energy absorbed along the path of the ionized particle.

This linear energy transfer to the biological media is defined either in terms of specific ionization, the number of ions per unit of path length, or in terms of linear energy transfer, the loss of energy along the path of the ionizing particle.

• **Valid doubts**—A. M. Weinberg, Director, Oak Ridge National Laboratory, says the measurements of solar flare radiation, if not Van Allen Belt radiation, are uncertain by a factor of 10. He adds that the RBE of fast heavy particles used in all of the calculations on space shielding have been much lower than the RBE recommended in Handbook 69 and used in shielding estimates required for the manned nuclear aircraft.

Weinberg says the difference is usually justified by the difference in energy of the radiations in the two

(Continued on page 59)

Reeves

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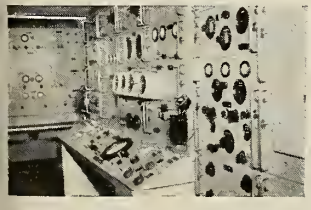
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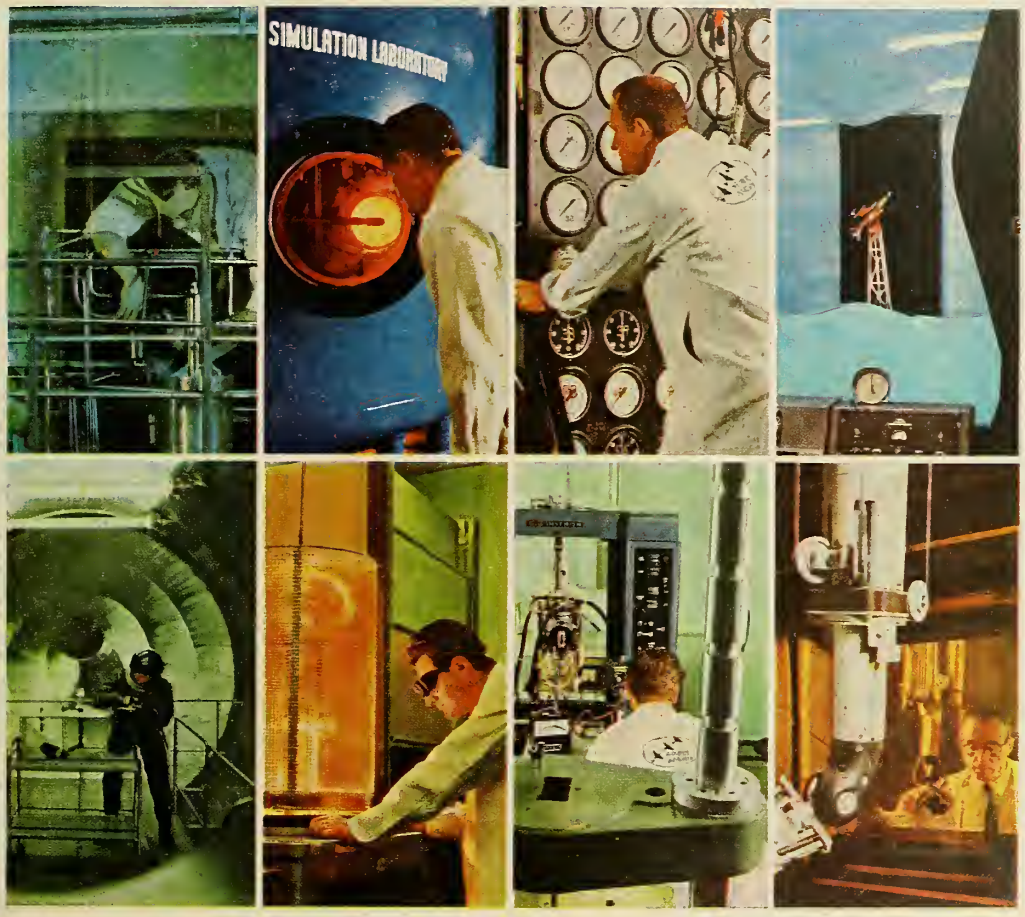
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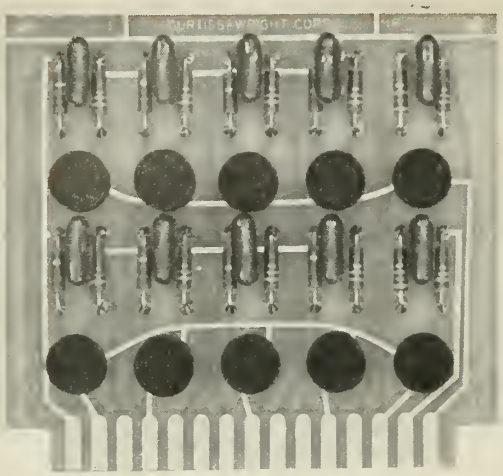
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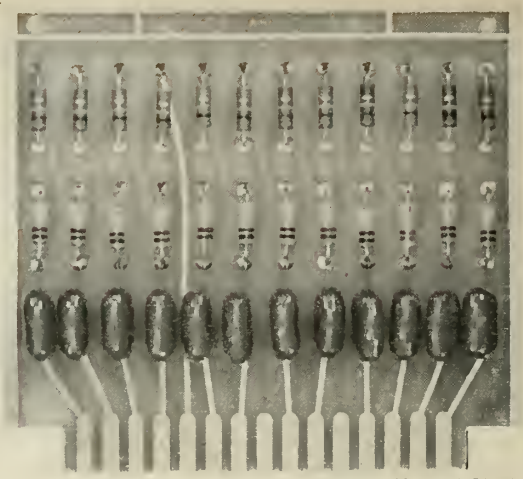
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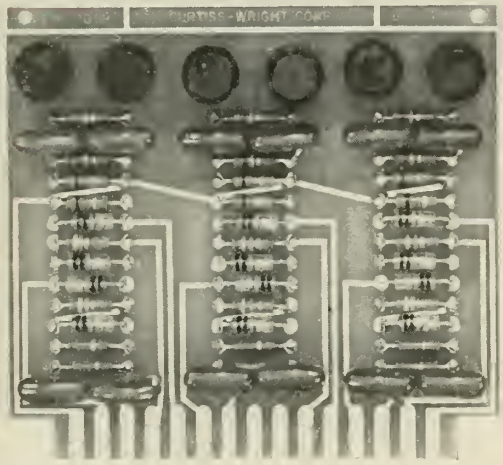
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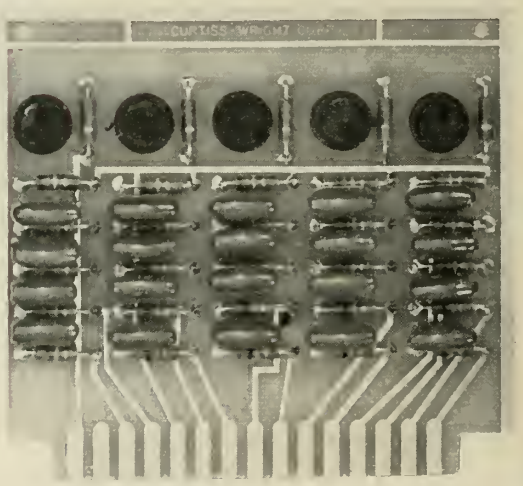
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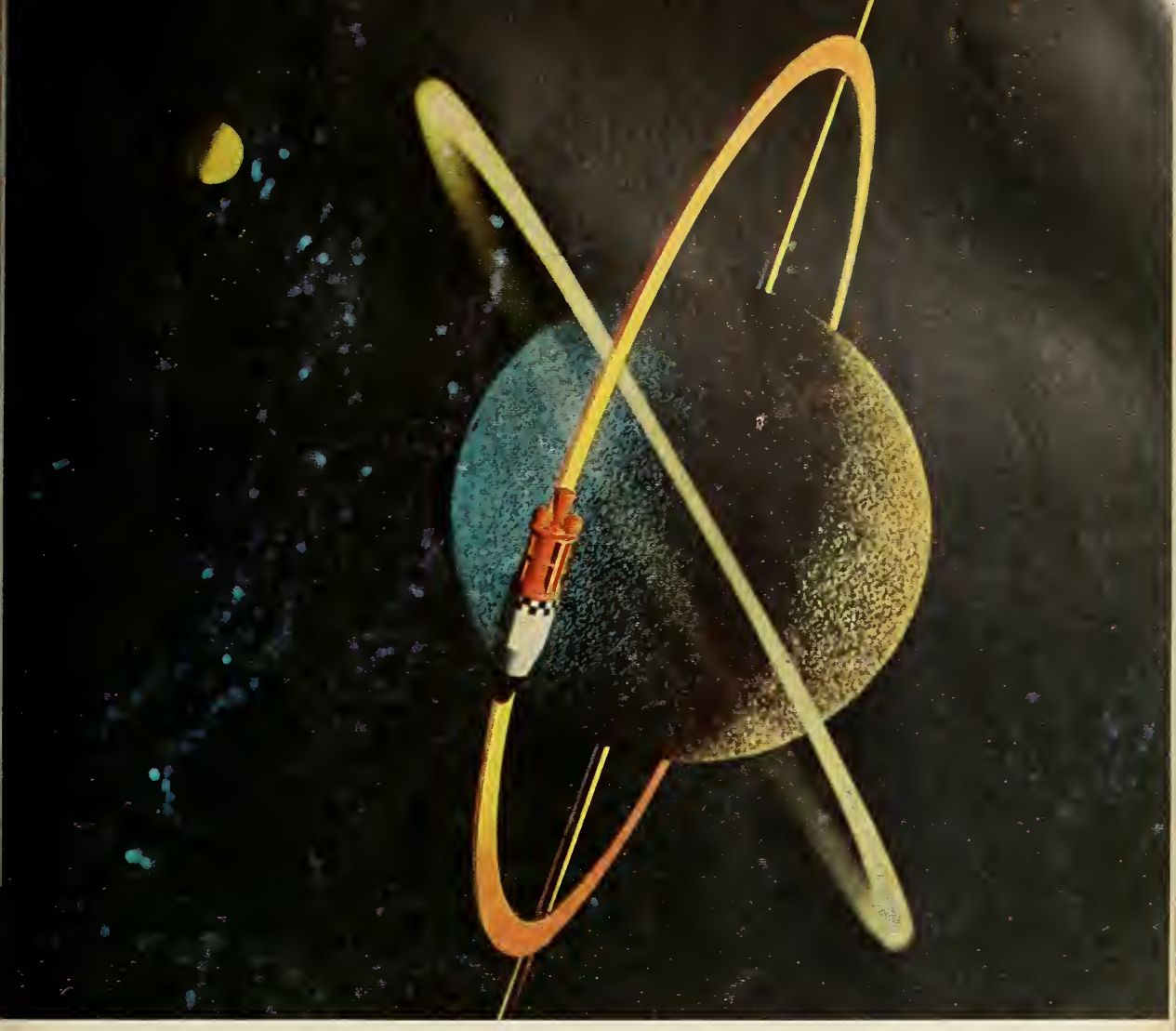
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Bell-powered Agena satellites in orbit — symbolized.

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The Agena engine, designed with space in mind long before space became a household word, has fulfilled its every mission and has placed more tons of useful payload into orbit than any other power plant. Its operational reliability is backed by six years of development and 5,000 test firings.

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Agena's engine is typical of the exciting projects in Bell's rocket propulsion center. It is part of the dynamic new approach of a company that's forging ahead in rocketry, avionics and space techniques. These skills serve all government agencies. Engineers and scientists anxious for a new kind of personal challenge can find it at Bell.

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EXPLORING THE HIDDEN SURFACE OF THE WATER PLANET



EG&G Underwater Camera, Light and Sonar System

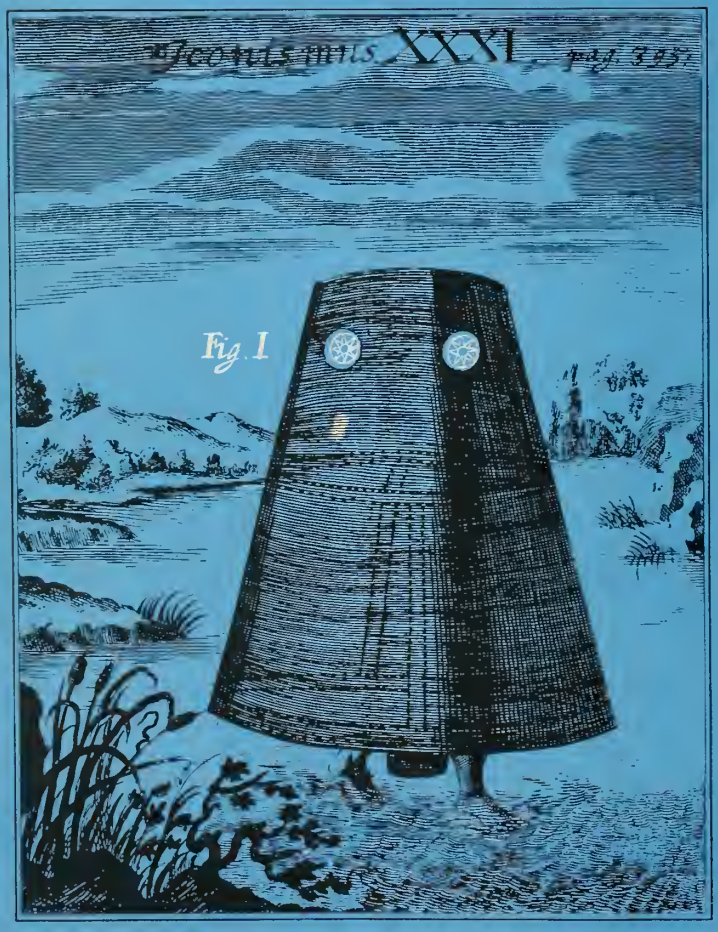


Fig I 17th Century Diving Bell.

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(Continued from page 50)

cases—space radiation, being harder, has a low linear energy transfer and therefore should have a low RBE.

But the total experimental evidence on the relative RBE of very fast particles is not very large and, in any event, the secondary particles produced in spallation processes, such as occur with energetic primaries, are in the binding energy region, not the 100 Mev area.

The Air Force report notes that the effects on living systems of all ionizing radiation begin on a biochemical and biophysical level and, depending on the magnitude of the dose, may be immediate or delayed. But there are many physiological factors which determine the effect of total body radiation—that radiation most likely to occur in space. There is little doubt that among men there is a considerable variation of sensitivity. The fact that 300 rem will be lethal to one man and 1000 to another, while both are apparently in equally good health, remains a mystery.

• **Leading from ignorance**—The lack of data forces the designers of spacecraft to assume the worst and prepare for it. Dose levels widely used today are drawn from and intended for those who work with radioactive substances. Breaking down these values with respect to space radiation effects on an astronaut leads to a great level of disagreement among the experts. There is also a recovery factor, which offers possibilities for more flexible definitions of dose permissible for man in space.

The shielding question is usually treated in terms of active and passive methods. The overall problem, stated in terms of lead shielding by Norris, illustrates the magnitude of the situation.

Weights of lead shielding less than some 10 to 20 lbs./ft.^{2} are essentially as useless for stopping inner Van Allen radiation as they are for cosmic rays. Extremely heavy weights of lead are required to reduce dose rate appreciably.

Passive shielding simply means the use of inert materials to absorb or deflect the incident radiation. S. F. Singer has concluded that a composite shield is needed to combine the proton-stopping power of low-atomic-number elements with the generally desirable characteristics of the high atomic number of lead. But Norris points out that unless the exact spectrum of energetic particles to be shielded is known, the design of a composite shield more effective than lead appears hardly feasible.

Norris suggests that it might be fruitful to take advantage of the generally oriented nature of space radiation, and the fact that protons are decelerated in a material in essentially straight lines. On this basis, if the shield is oriented askew relative to the path of the incident particles the protons will travel in part along the shield instead of directly through.

Thus a thin, saucer-shaped vehicle oriented edgewise to the radiation should be more effective than a sphere.

Active shielding involves the use of electrostatic or electromagnetic fields to deflect the incoming protons. Norris says that the assumption must be made that protons are the particles to be shielded; if energetic electrons are encountered in significant quantities, they are prevented from penetrating by some additional type of shielding.

In electrostatic shielding, the rejection potential in volts must be numerically equal to the kinetic energy of the incoming proton in electron volts. Then, in order to protect a sphere of any radius against protons in the 200 Mev range, it must be given a positive charge equivalent to 200,000,000 volts.

The concept does not appear encouraging, inasmuch as ground-based electrostatic accelerators using heavy equipment achieve only some 10 million-volt potentials. But the vacuum in space should permit the build-up of much higher charges than are possible in the atmosphere.

Electromagnetic shielding suffers a weight penalty in the needed equipment, and the vehicle has to be properly oriented to give equatorial incidence to the incoming radiation. There are also complications in the operation of a vehicle within an intense magnetic field.

• **The great compromise**—The task of shielding man for extended durations in long space missions is quite formidable. The short-flight approach involves certain avoidance techniques—such as that envisioned by the Martin *Apollo* studies. There is also the possibility of including a "storm cellar" in a craft for use during high radiation flux.

The storm cellar could be combined with avoidance techniques for a larger margin of safety. A. D. Goedeke says that it may be possible to avoid major solar activity during the 11-year cycle. (M/R, April 17, 1961, p. 31.)

One other method involves designing the spacecraft in such a manner as to put all equipment between the man, or men, and the environment. This seems to be the procedure followed in the Martin studies. There the capsule surface was divided into 500 separate segments. Positioning equipment left only a dozen or so to be shielded.

The great lack of reliable information is constantly cited as the major immediate problem.

It is generally agreed that exposures close to the level of acute injury must be accepted as inevitable in space flight. Many experts feel that space flight radiation studies in a biochemical and biophysical sense have been neglected.

On May 4, 1961, a special subcommittee of the House Committee on Science and Astronautics heard this from Col. Charles H. Roadman, NASA Director of Life Sciences Programs:

". . . I think it is evident in their (Russia's) program that they have had . . . an extensive biological in-flight effort. They have had some six flights with a considerable number of biological specimens being on board.

"As it relates to our program, we are really behind, if you want to put in this comparison, in our ability to put biophysical level and, depending on the

It seems that the U.S. is once again long on theory but short on results—where they count. ⁂

MONTH	IMPORTANCE (1−)	1	2	3 AND 3+	TOTAL
1957 JULY	28	334	39	5	406
AUG	36	320	25	2	383
SEPT	50	368	53	10	481
OCT	71	436	21	2	530
NOV	35	275	18	2	330
DEC	37	298	27	0	362
1958 JAN	13	196	23	1	233
FEB	9	215	24	0	248
MAR	38	352	54	4	448
APR	35	295	14	1	345
MAY	53	313	18	2	386
JUNE	91	254	32	1	378
JULY	90	340	31	3	464
AUG	86	335	33	4	458
SEPT	71	305	28	1	405
OCT	27	279	23	0	329
NOV	29	189	14	2	234
DEC	36	285	20	1	342
TOTAL	835	5389	497	41	6762

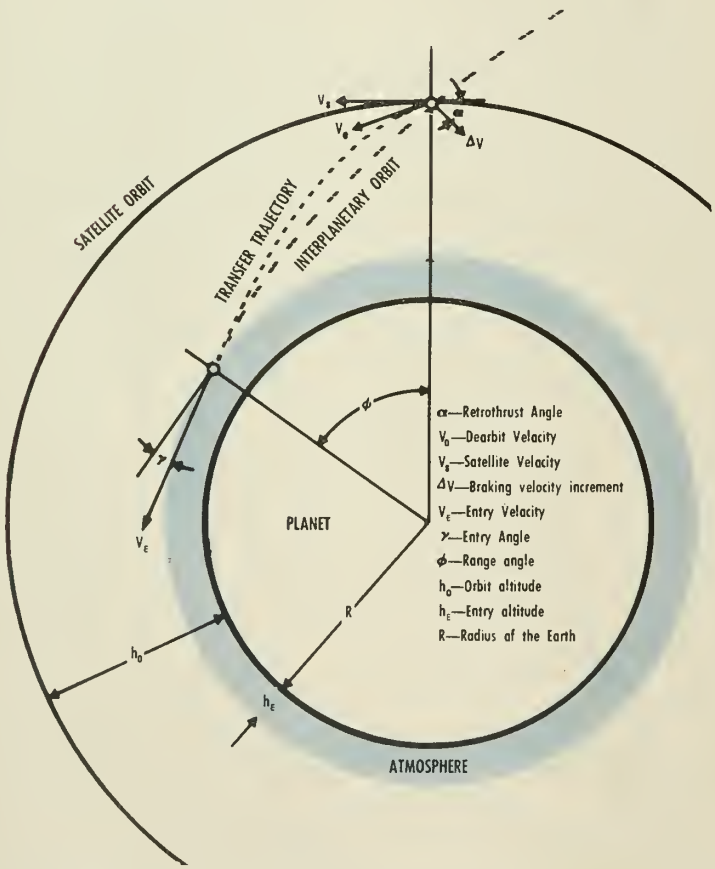
CATALOGUE OF SOLAR RADIATION EVENTS detected during the IGY. Importance figures denote the area of disk on the sun at maximum brightness.

To hit entry corridor . . .

Descending Space Vehicles Should Hav

Current studies point to difficulty in solving ballistic entry; Douglas advances a blunt delta wing concept with high lift and "roll" to maintain constant attack angle

by John W. Herrick



ENTRY ANGLE as shown in graph will be critical—particularly for craft returning from interplanetary orbit. High g will result at 6° or more.

A MANNED spacecraft correctly designed for entering an atmosphere—whether earth's, Mars', or some other planet's—must satisfy three major requirements.

It must have a heat shield, insulation, and other equipments that will prevent overheating of the load-carrying structure and the internal contents—including frail humans—during entry from space as the vehicle dissipates its kinetic energy.

The spacecraft must be operated and controlled in a manner that prevents overstressing the human passengers and the structure during deceleration by the atmosphere or application of reverse thrust (retrothrust). In short, keep the g-load within tolerable limits.

Lastly, the landing craft must have maneuverability and controlability that will make it possible to land at a desired location, preferably a ready airfield. This is the aspect of manned space travel that will next receive large-scale attention now that the *Mercury* program, the Gagarin flight, and the *Discoverer* recoveries have demonstrated the feasibility of re-entry in the manner of ballistic nose cones.

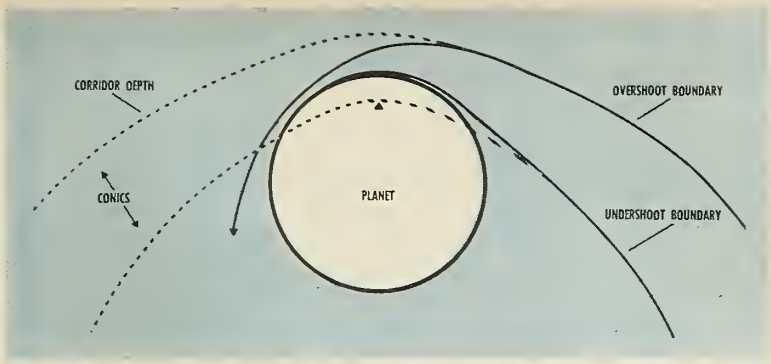
Suborbital flights of the *Mercury Redstone* capsule down the Atlantic Missile Range resemble ballistic trajectories except for the deployment of a parachute to obtain final deceleration before dropping into the water. Some authorities question the value of these flights because the capsule does not adequately simulate true orbital re-entry.

There are other requirements, believed to be minor compared to those noted above but important nevertheless, that should be considered in a thorough study of return, re-entry and recovery.

1. The manned vehicle should be reusable. (This is in line with current plans to recover the large and expensive rocket boosters.)

2. The system should be capable of acceptable entry from the moon or the planets as well as from an earth orbit. Simply stated, the system would work at 35,000 ft./sec. (near escape velocity)

Variable Drag



NARROW CORRIDOR emphasizes danger of undershooting or overshooting earth. Returning astronauts could miss proper angle and whiz into space again.

as well as at the velocity for a low-altitude satellite; for example, 24,000 ft./sec.

3. The system should be usable for an emergency recovery at any time during ascent from the launch pad.

4. The pilot should be a functioning part of the control loop during descent and should have adequate communication through the plasma sheath that builds up in front of an entering object.

5. Materials used in the spacecraft structure should be compatible with space as well as earth environments.

• **Variable drag must**—Conclusions reported by the experts at the Lifting Re-entry Vehicles Conference managed by the American Rocket Society at Palm Springs were generally in agreement with authorities subsequently consulted at Douglas Aircraft Co., Space Technology Laboratories, Radioplane Division of Northrop Corp., and North American Aviation.

The manned re-entry vehicle must have some capability for varying its drag during descent from orbit.

If this drag modulation is accomplished by using a lifting-type vehicle, the maneuverability and controlled landing problems are greatly lessened.

Uncontrolled landing anywhere in the predicted 50-by-300-mile ocean area for the *Mercury* astronaut is hardly conducive to establishment of acceptable space transportation. Studies of the combined effects of errors in retrothrust angle, variation in total retrorocket impulse (output), and expected tracking accuracy with the *Mercury* network at the time of retrorocket-firing lead to one big question—how far from the center of the desired landing area will the *Mercury* astronaut actually touch down?

The original planning of the *Mercury* program, however, was logical on the basis of the then-current state of the art, the limitations in financial and political support, and the natural desire to orbit an American as soon as it could be done with minimum risk.

It becomes obvious to those who seriously study entry and recovery technology that the returning vehicle should have some of the design features of a supersonic airplane. Ballistic-type nose cones that decelerate by compressing the atmosphere they are ramming through are acceptable only for the initial tests and investigations.

• **One solution**—The Douglas thick-wing planetary vehicle, proposed by Gervais, duPont, and Lowe, attracted considerable interest at the Palm Springs meeting. This concept provides a means of reducing both maximum heating rate and total heating by entering the atmosphere with the winged vehicle placed at a high total angle of attack.

Total heating encountered and maximum deceleration loading are significantly reduced by a controlled angle of attack. Because this concept is typical of other lifting-type entry vehicles, the major design features will be reviewed.

An exhaustive review would include features and discussion on *Dyna-Soar*, advanced *X-15*, asymmetric lifting bodies, and the folded-wing configuration proposed by Eggers of NASA.

• **Re-entry fundamentals**—Most investigators examine the entry problem from the point of view of the entry velocity of the vehicle. The two broad classes are: The velocities appropriate to low-altitude earth satellites, about 26,000 ft./sec, and those appropriate to return from space (for example, our moon), about 35,000 ft./sec.

Dr. John Sellers of Space Technology Laboratories divides the entry portion of the return trajectory into three regions.

The first region is that of the extremely high altitude where the returning spacecraft is first affected by the atmosphere. The second region is where extremely high heating and deceleration are experienced. The third is the terminal region where the aerodynamic forces acting on the vehicle are comparable to the force of gravity (the region of "slow fall") and the re-entry body actually begins to cool.

It is instructive to consider this general entry trajectory in more detail. For simplification a zero-lift body is used as an example.

A nose cone will start to oscillate very slowly in the first region. If it is a statically stable nose cone, the angle of attack will thereby be greatly reduced. The forces causing this, however, do not reduce the velocity. In fact, the vehicle may even accelerate slightly because of gravitational attraction. It is during this regime that an attitude-control system should damp out the oscillatory motion.

At an altitude of approximately 200,000 ft., depending somewhat on the design, the nose cone enters the second region. The body drag will just equal the acceleration due to gravity, and the nose cone will reach maximum speed. From this point on, the drag builds up so rapidly that the gravity term in the analyses can be completely neglected.

It is during this region that the extreme deceleration loads and heating rates commonly associated with re-entry are experienced. It is here that the kinetic energy (a heavy mass of several thousand pounds at velocities above five miles per sec.) is used up by producing thermal energy in the surrounding atmosphere.

• **Balloons & Gliders**—During the terminal region, the "slow fall," the major problem is aerodynamic stability, and gravity has to be considered. It is in this region that various drag or deceleration devices would be useful. The major aerodynamic decelerators that are being studied include attached types and trailing types, categorized by the manner that they are connected to the landing vehicle.

A list of the attached types would include: Autorotors, semirigid flaps and spoilers, rigid flaps and spoilers of which extensible flares is one popular design, and the Rogallo paraglider (see M/R, May 15, p. 40). Parachutes of all shapes and arrangements lead the list of trailing decelerators. Others are balloons, cascades (a strung-out series of plates, cones, etc.) and towed afterbodies.

Although the entry velocity of a body is an important factor to be con-

(Continued on page 94)

Market seen stable . . .

Guidance/Control Know-How Is Ample

Main job for manufacturers is systems integration—
Dyna-Soar needs have taken shape but debate over Apollo continues

by Charles D. LaFond

EXISTING guidance and control hardware types and techniques are expected to be used in the new space vehicles *Dyna-Soar I* and *II* and *Apollo*.

Hence these G&C systems will not be delayed by any lack of technological know-how, and the principal task facing manufacturers appears to be systems integration.

The total guidance and control market for manned space vehicles, in fact, will not exceed $115 million over the next five years. Industry observers say that because of the very small number of existing programs and their inherent low production potential, the market will be stable for the next five years—and possibly throughout the next decade.

Dyna-Soar G&C requirements are now fairly well set, but among the prime-contract contenders there are conflicting views as to what approach would be best for *Apollo* guidance. Some would prefer to rely heavily on radio command; others believe all-inertial is sufficient as the primary subsystem. All expect that some form of celestial navigation backup and mid-course guidance will be employed.

There is unanimous agreement that man will greatly complement and possibly even simplify guidance and control systems for relatively long-distance flight vehicles.

• **Market low, steady**—About 20 percent of the 1961 $90-100 million space G&C total will be directed toward systems for manned space vehicles. This figure includes R&D. Further, it is not expected to vary a great deal over the next 5-6 years.

The market in calendar year 1961 is expected to reach about $22 million.

There are four current or projected programs: *X-15, Mercury, Dyna-Soar I,* and *Apollo*. Only the latter two will continue to require any sizable expenditures. *X-15* and *Mercury* have reached the point where hardware and product improvement account for almost all funding and these are diminishing markets.

Dyna-Soar I probably will phase out in 1964-65 as *Dyna-Soar II* comes into development. Cost of the whole *Dyna-Soar I* G&C system is expected to run from $45 to $50 million. Nearly $5 million has been allocated so far by Air Force and Boeing to Minneapolis-Honeywell, developer of both systems. This should reach $6 million by the end of this year, then steadily increase.

By the end of this year or early 1962, the first *Apollo* contract—probably preliminary design—should be awarded. Total G&C development cost up to and including the circumlunar vehicle is estimated to be anywhere from $20 to $30 million. Over what time period this will be spent is not now known.

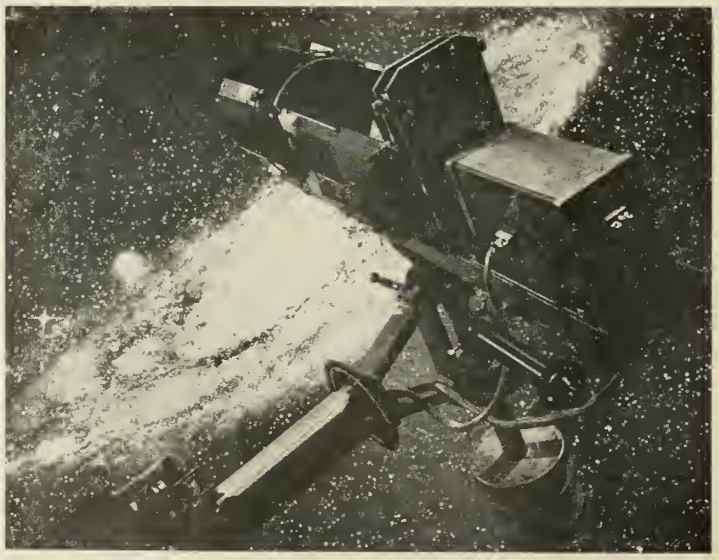
Only a relatively small amount of government funding has supported the just-completed *Apollo* feasibility studies. Martin, General Electric, and Convair each received $250,000. The unknown quantity here is how much each invested of this amount plus company funds for the G&C studies performed by Arma and Autonetics (for Martin), Nortronics (for Convair and by GE itself. Added to these totals would be expenditures by companies like Boeing and McDonnell who performed the entire study solely on company funds.

Around 1964, *Dyna-Soar II* will be phased in. Also, it is very possible that the often-mentioned Aerospace Plane may come into being in 1963 or 1964. Both will add more money to the pot.

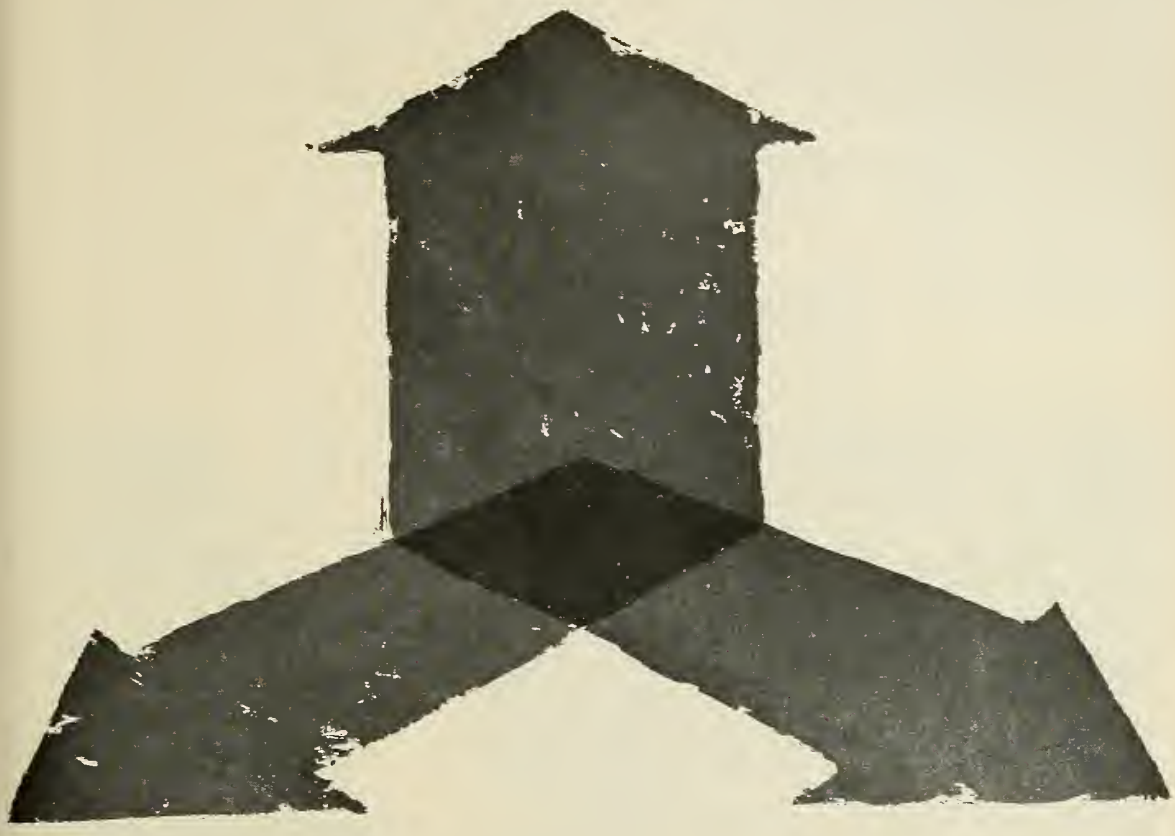
With all these imponderables in in mind, the best (conservative) projected estimates for the manned-vehicle G&C market look like this:

1961—$22 million
1962— 28.5 million
1963— 22 million

(Continued on page 65)



STAR FIELD TRACKER is capable of navigating a spacecraft, stabilizing it in flight, and guiding it to landing on moon's surface. Tracker, developed by Martin Co., simplifies space-navigation problem by map-matching against selected constellation of group of stars as reference point to determine spacecraft's orientation and produce necessary signals to guide it on its path. With same techniques, device can follow approaching lunar contours to guide vehicle to preselected landing point on the moon. System can be used as backup for Apollo inertial guidance system.



Said Hans Oersted: *"When a conductor carries current through a magnetic field at right angles to it, the resultant reaction thrusts the conductor in a direction perpendicular to both the current and the magnetic field."*

A light-weight, low fuel-consuming propulsion system is a primary requirement for interplanetary space vehicle travel. One such system now being carefully studied utilizes plasma propulsion.

This concept employs an electrical field to produce a plasma and to energize it. A magnetic field then ejects the plasma, thereby providing a reactive thrust to the vehicle.

Plasma propulsion is but one of many subjects under investigation at Lockheed Missiles and Space Division. Outstanding facilities, equipment and scientific personnel mark the organization as eminently capable of exploring many unusual aspects of space travel. This, coupled with Lockheed's favorable locations in Sunnyvale and Palo Alto on the beautiful San Francisco Peninsula, consistently attracts scientists and engineers interested in pursuing work in their special fields.

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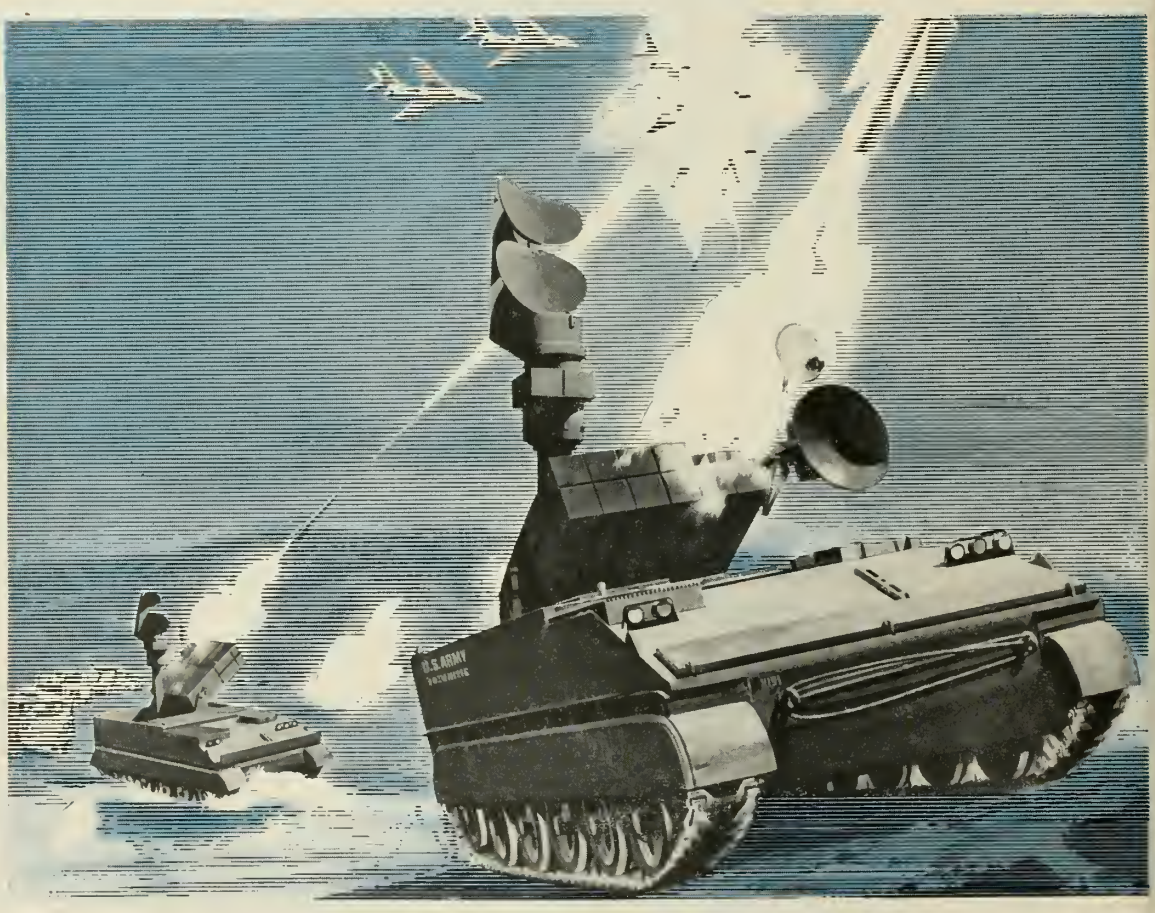
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(Continued from page 62)

1964— 16.5 -18.5 million
1965— 15-22 million
Total: $104-113 million

• **Dyna-Soar G&C**—Requirements for the Air Force's experimental boost glider, *Dyna-Soar*, will be rigid. The manned delta-winged hypersonic vehicle must permit complete control by its pilot from launch into orbit, during orbital coast, and throughout its gliding re-entry and subsequent landing. All this will be accomplished within a circle of maneuverability of several thousand miles diameter.

Velocities will range from nearly 18,000 miles/hour (orbital speed) down to conventional military jet-aircraft landing speed.

Primary guidance and the adaptive flight control system for the craft will be developed by Minneapolis-Honeywell Regulator Co.

The guidance subsystem will include a four-gimbal inertial platform, platform electronics, digital coupler and power supply, malfunction detector, and digital computer. Most of the inertial system is identical to that supplied by M-H for the *Centaur* program. Also, it is believed the *Dyna-Soar* guidance system will have a somewhat less sophisticated backup inertial platform.

Seven years in development, the prototype of the automatic electronic flight control system is scheduled for testing this September in NASA's *X-15*. Because of the similarity of operation, design problems, too, are similar for the two vehicles. The *X-15* should produce meaningful data leading to final development of a reliable, high-performance system for *Dyna-Soar*.

The reason for the complexity of such a system is the difficulty in merging technologies of aerodynamic and reaction controls. Switchover from one technique to the other must be performed smoothly, and at the opportune time, to achieve optimum performance and fuel efficiency.

Dyna-Soar I will not be orbital. First tests will involve airdrop and ballistic unmanned flights. (For more details of *Dyna-Soar* G&C, refer to M/R, Feb. 27, 1961, p. 45.)

• **MAN control?**—Reportedly, Boeing Co., prime contractor for the vehicle program, is considering the use of a microwave guidance subsystem for recovery, at least during early phases of the test program.

Developed by Sperry Gyroscope Co., a Division of Sperry Rand Corp., the Microwave Aerospace Navigation System (dubbed MAN) will remotely control descent and landing of the spacecraft with great accuracy.

Employing long-range radar, MAN

(Continued on page 70)

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Dorsett has designed, developed and manufactured the transistorized subcarrier oscillators, associated reference oscillator, and power supply mixer-amplifiers that will frequency-modulate and multiplex data in the Mercury manned satellites into transmittible and recordable form. These Dorsett-built components consistently meet McDonnell's standards.

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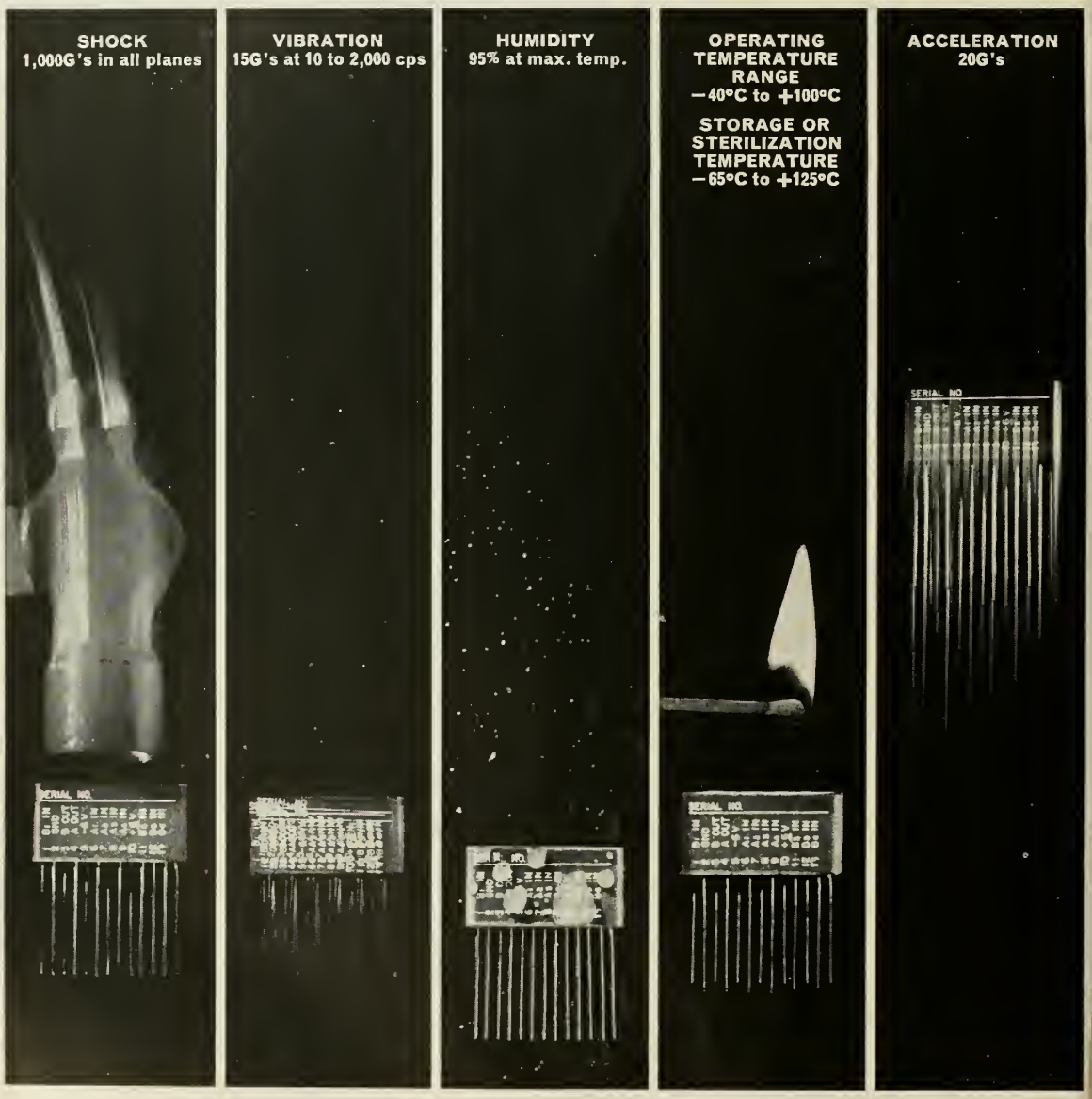
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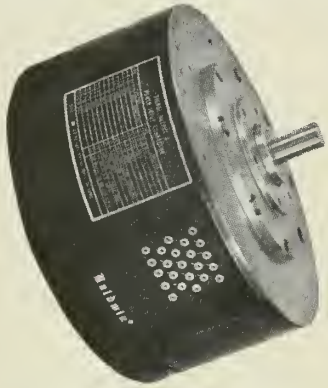
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(Continued from page 65)

takes over the navigation functions of the craft's own inertial guidance system. The system calculates and maneuvers a smooth approach, dissipates excess airspeed, and safely lands the vehicle at a prescribed point.

Any system of this type will have to acquire the vehicle just before reentry, follow it through, and at the same time calculate the re-entry corridor based on the point of initial injection. Obviously, a severe communications problem will exist during this phase because of the ion plasma sheath about the vehicle. This envelope attenuates radio energy over a range of frequencies from 100 mc to 10 kmc.

To overcome this problem and to provide accurate position and velocity data, Sperry has suggested use of a narrow-beam radar, extended by a beacon for longer range and employing a high X-band frequency. Command data will be provided by PCM (pulse code modulation) telemetering to and from the vehicle.

Radar, command link, and telemetry link functions can be integrated into a single system, Sperry says, to minimize hardware and greatly increase reliability.

The X-band radar interrogator used in MAN employs a PCM 5-kw magnetron transmitter with a very-low-noise receiver.

An 8-foot paraboloidal reflector antenna with a 0.9-degree beamwidth will be used for automatic tracking. This, says Sperry, will provide an angle tracking accuracy better than 1 milliradian rms.

A flight path computer will provide x, y plots and altitude. A miniaturized data transponder would be carried aboard the vehicle.

The addition of multiple ground stations and/or air relay stations tied together would add much greater flexibility to the recovery control system.

• **Apollo and beyond**—On the first major space trip—lunar circumnavigation and return—guidance will be one of the critical technical areas (others include thermal, meteroid impact, radiation protection). There are conflicting ideas as to just how tough the problem really is.

Dr. Albert C. Hall, Martin v-p/engineering, has described requirements for such an *Apollo* mission as follows:

Perfect coasting or "free fall" lunar flight requires an initial velocity of about 24,500 mph, or 36,000 ft./sec. Just to hit the moon, the guidance must guarantee an accuracy of within 75 ft./sec. and 0.5 degree of the planned flight path.

To circle the moon and return safely, the overall tolerances are considerably more severe: within 1 ft./sec. and 0.001 degree. This accuracy is roughly 20 times better than that required for an effective ICBM, Hall said.

Midcourse guidance and, of course, propulsion must be employed to achieve these accuracies.

NASA's Chief of Manned Space Flight, George M. Low, in his report "Manned Space Flight" said that trajectory control will impose very severe requirements on the navigation and control systems.

With a midcourse guidance correction capability, others feel, the problem is not so difficult. They believe there is a general misconception with regard to the long-distance guidance task.

Last fall, three Jet Propulsion Laboratory experts—C. R. Gates, A. M. Noton, and E. Rechtin—presented a paper before the Fifth Space Electronics and Telemetry Symposium in Washington which stressed that injection accuracy comparable to that of an IRBM would be more than adequate.

Their hypothesis is based on the employment of a "fuel-cheap midcourse maneuver" derived from inputs from moderately accurate radio tracking during the first several days of flight. Tracking errors, they said, need not be small, but they must be stable for compensation in the orbit computer programing.

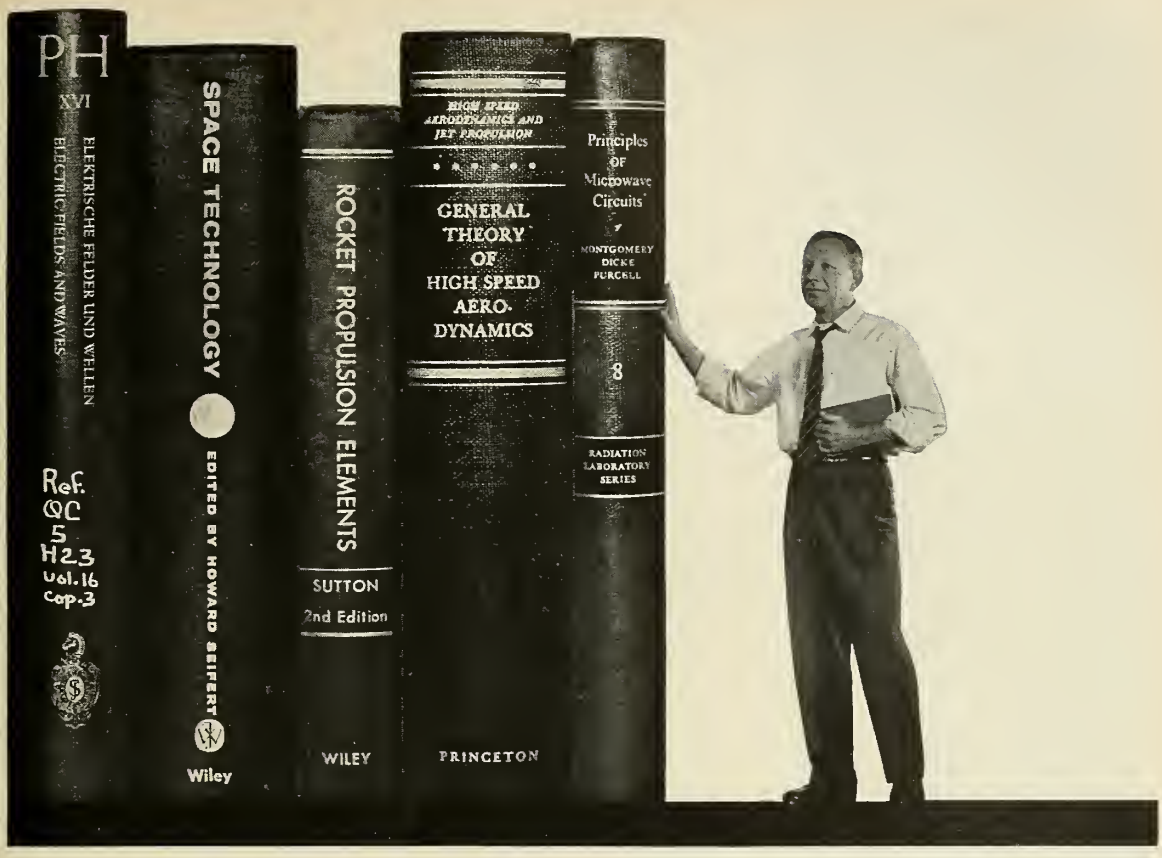
With present application technology, G&C components have expected life of several hours maximum; for space use there must be several thousand hours minimum, says Gerhard B. Heller, deputy director, Research Projects Div., Marshall Space Flight Center.

• **Human control?**—In a comparison of man versus machine in the functional role of spacecraft control, man shows up very favorably. The original argument as to whether man could be truly useful seems strongly settled in favor of the man-machine combination, rather than just the machine, for every scientific role in space except near-space exploration and pure experimentation. For exploration, fabrication, maintenance, inspection, surveying, and piloting (particularly docking and landing), man obviously has attributes which either complement or greatly exceed the machine.

It is significant that the strongest technological barrier today to manned space flight is not an electronic or electromechanical equipment deficiency but the booster state of the art.

As for man himself in the control function, apparently most studies to date state that: (1) man can survive and perform as required, and (2) no limitations have been observed yet which will limit seriously man's normal

(Continued on page 73)

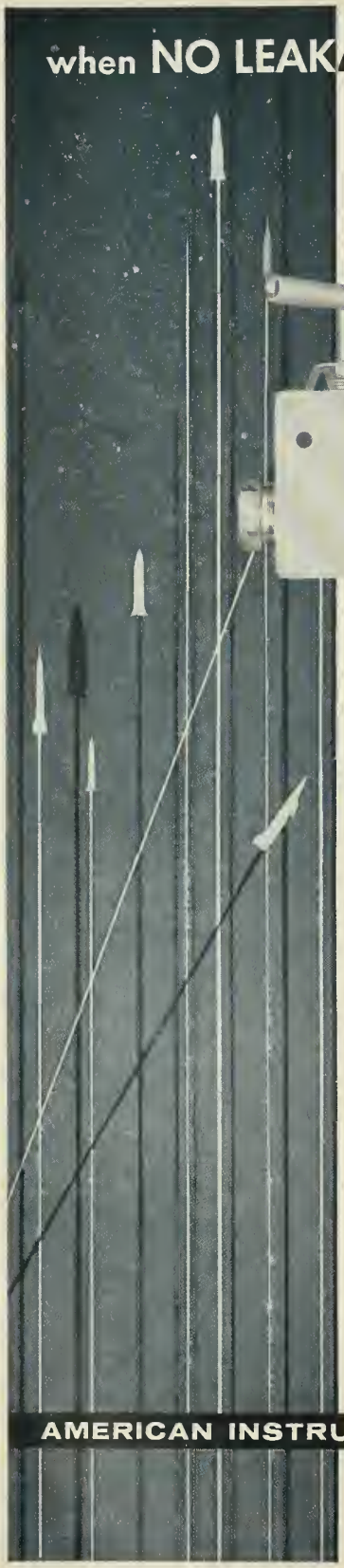


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Before introducing this new group of valves commercially, Aminco contracted with Wyle Labs, El Segundo, Cal. to subject prototype units to the rigid U.S. Air Force Evaluation Test Specifications for Propellant Loading (AMC, Ballistic Missiles Div.), and render a performance evaluation report. The test included internal- and external-leakage and proof cycle tests throughout 500 operating cycles. The Wyle program confirmed Aminco's pre-production tests . . . valves operated easily, and with COMPLETE FREEDOM FROM LEAKS, not only internally at the valve stem seat, but also around the valve packing.

The valve is well-suited for severe service and where absolute freedom from leakage, from excessive stem wear, and from packing deterioration are MUSTS. The valves embody a floating non-rotating stem tip which prevents the possibility of forcing the stem into the seat. Four models are available for applications ranging from the propellant loading of missiles to chemical and petrochemical plant service. Valves are easy to install . . . easy to operate. Bodies are constructed of 316-stainless steel; trim is of 400-series stainless steel except the packing gland nut which is of aluminum bronze.

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All four types are available from stock . . . all valves have 5/16 in. port openings, and are designed to accept 9/16 in. o.d. x 5/16 in. i.d. tubing. Dimensions common to all four styles: width, 2½ in.; body thickness, 1½ in. Packing is a compression-type, glass-filled fluoroplastic flat ring. All styles are furnished complete with necessary nuts and sleeves.

Order by Catalog Number:

44-1317 Two-way Thru Type Valve—As described and illustrated above. Height of valve body, 2-15/16 in.; over-all height, 5¾ in.

44-1337 Two-way Angle Type Valve—With port on one side and on bottom of valve body. Height of valve body, 3-3/16 in.; over-all height, 6 in.

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(Continued from page 70)

operating capability.

The biggest unanswered question remains, however: How long can man perform in conditions of high radiation, weightlessness, isolation, etc.?

In his control function, man offers many characteristics vastly superior to the machine. He is self-programing, very flexible and adaptable. He employs a learning system, reasons inductively, and has an urgent interest in survival. As for reliability, man is not subject to catastrophic failure if before flight he is capable of passing exacting inspection.

Finally, man's weaknesses can be guarded, corrected, supplemented or completely bypassed by the machine.

One large question—how to assign decision-making—remains to be resolved. But this probably will have to be accomplished through experience. The question lies with degree or division of responsibility.

• **Reliability improved**—On any extended space flight, G&C will be one of the major systems requiring adjustment or repair. Here man's maintenance value could be highly rewarding.

According to Donald E. Burris, of General Electric's Missile & Space Vehicle Department, studies have shown that reliability of an unattended space system varies from 0.97 at the end of 1 hour to 0.20 after 12 days in flight.

However, by adding man for making adjustments, reliability after 12 days is held to 0.70. If repairs also can be made, reliability decreases only to 0.94.

It is true, he said, that longer unmanned flight periods are possible—but at the penalty of greatly reduced effectiveness.

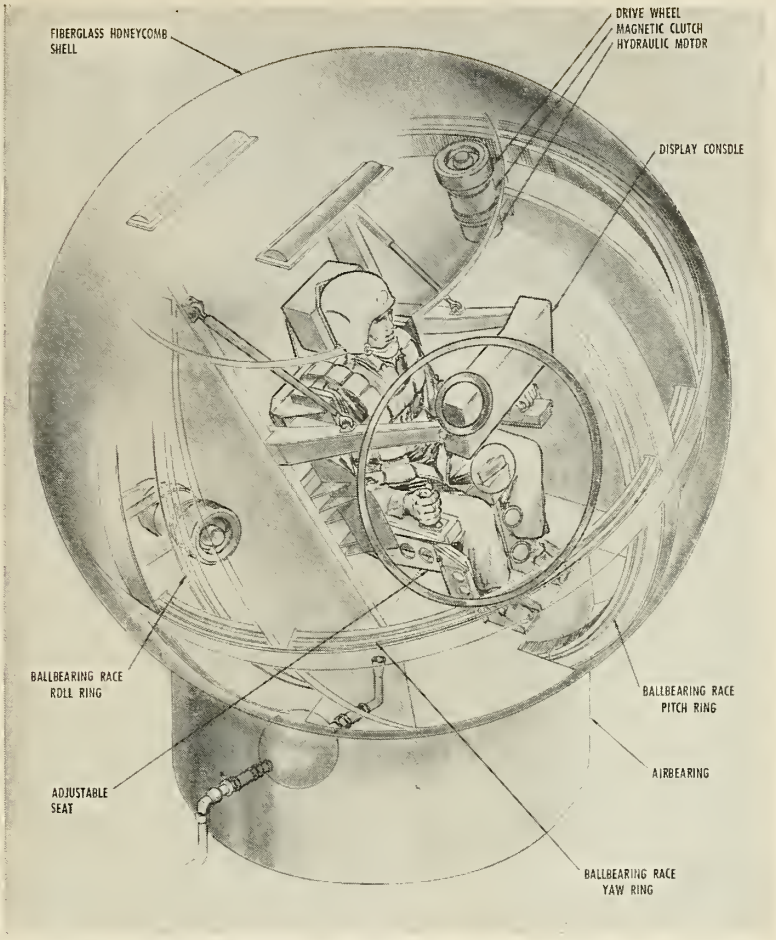
• **Two G&C approaches**—Since NASA is contemplating the use of modular spacecraft design for *Apollo,* the command center module probably will be the same for earth-orbital missions and for circumlunar flights. This will be the flight control center, and also the reentry vehicle. Primary control will be on board rather than from earth, according to Low.

Major system developments needed for *Apollo,* as listed by Low, include attitude control system, G&C system, pilot displays, communication system, and power supplies.

A circumlunar mission, he has suggested, would require power of the order of 400 kw-hours with peak load of about 4 kw.

Both voice, telemetry communication, and possibly TV would be needed.

As for G&C requirements, those concerned take two distinct design approaches. Some believe in the need for a highly redundant hybrid system which would provide, basically, a multiple (possibly three) inertial stable platform, star trackers, and radio guidance.



RIGOROUS GUIDANCE AND CONTROL training will be possible when Norair Division of Northrop Corp. delivers this flight rotational simulator to the Air Force School of Aviation Medicine. Ten-foot fiberglass sphere can rotate up to 70 rpm on yaw, pitch and roll axes. Air-bearing or "ground-effect" support of the simulator sphere and the ball-bearing support of the steel rings allow rotation with little resultant friction, and thereby simulates the frictionless environment of space.

The system then takes on the appearance of a *Polaris* submarine navigation system. However, its proponents believe it need not be nearly as massive or as complex.

The radio guidance would be flexible enough to accept control inputs from earth at the beginning and end of the journey. It might also be desirable to employ radar terminal homing from midcourse onward.

A digital computer can be employed to fully integrate all the control inputs, perform continuous calculation to refine the data, and directly or indirectly implement control with necessary commands.

The second approach is much less complicated. The primary guidance would be a sophisticated (but not necessarily newly developed) inertial system with another simpler inertial package for backup, as in *Dyna-Soar.* A celestial tracker would provide corrective data and radio would be used for altimetry measurements only.

It appears that the all-inertial versus radio-inertial argument in missilery has moved into space.

With the recent decision to employ a nearly-ballistic *Apollo* configuration (lift-to-drag ratio from 0.4-0.7) the control system will be primarily reaction-type. But NASA has indicated on all its re-entry vehicle configurations the inclusion of aerodynamic control surfaces. These will provide some small degree of maneuverability after entering the atmosphere.

Thus, the control system will have to provide for both reaction and aerodynamic controls. Such a system then

(Continued on page 100)

Space Is No Place for Untried APU's

Tried and true systems with heavy redundancy will fly with man to minimize risks; a report on advanced R&D

by William Beller

OBSOLETE auxiliary power units (APU's) will be used for manned space flight.

The APU's will also have a high degree of redundancy.

This was true during the manned *Mercury* flight, where nearly 150 lbs. of silver-zinc batteries redundantly connected formed the heart of the capsule's electrical system.

It will also be true for future manned flights, because an astronaut prefers a system aged and proven in use. He also wants it redundant, because no matter how reliable a system is there is always a degree of unreliability—which can be reduced only by having parallel systems.

Therefore, the advanced APU's will be flying only on unmanned vehicles. It will be years before such APU's become mellow enough to be used in a manned system. This is the reason for today's emphasis on new and exotic power sources—so that they will be ready for man when he needs them.

Even by 1965, probably none of the modern APU's will be sufficiently proven out. Thus, a National Aeronautics and Space Administration scientist working on APU's says that the *Apollo* manned spacecraft—which will require an average power of about 3 kw and a peak of about 5 kw—will probably use solar cells with batteries as the power conversion system. It is well known that solar cells are highly reliable and can be strung up in a circuit giving nearly any degree of desired reliability.

Although a 3-kw solar-turboelectric APU will probably be developed before the *Apollo* flights, there is strong doubt that the early versions will be sufficiently reliable to be used in the manned spacecraft. Another dominating drawback is that a single system would have no redundancy.

• **Definition of APU's confused**—All functioning space vehicles, except passive repeaters such as *Echo,* require APU's to operate instruments, radio communications equipment and tracking beacons. This is true for both manned and unmanned flights.

For manned flights, there may be an appreciably greater need for power to control the spacecraft's internal environment. However, even some unmanned vehicles need to have their internal environment actively controlled—if by no other means than opening and closing shutters to allow heat to be appropriately radiated.

The definition of auxiliary power as being something less than primary or propulsion power and playing little or no part in giving thrust begins getting fuzzy when applied to electrical propulsion systems. For example, can the advanced version of SNAP 8—putting out 60 kw which could be directly used in an electrical propulsion system—be called an APU? The semantics becomes even more pointed when later nuclear APU's—expected to be able to put out 1000 kw within the present decade—are built to give thrust to unmanned interplanetary probes and perhaps to manned lunar spacecraft.

For surveillance and reconnaissance work, such as the *Midas* and *Samos* satellites will be performing, highly efficient and reliable APU's can be a matter of national survival.

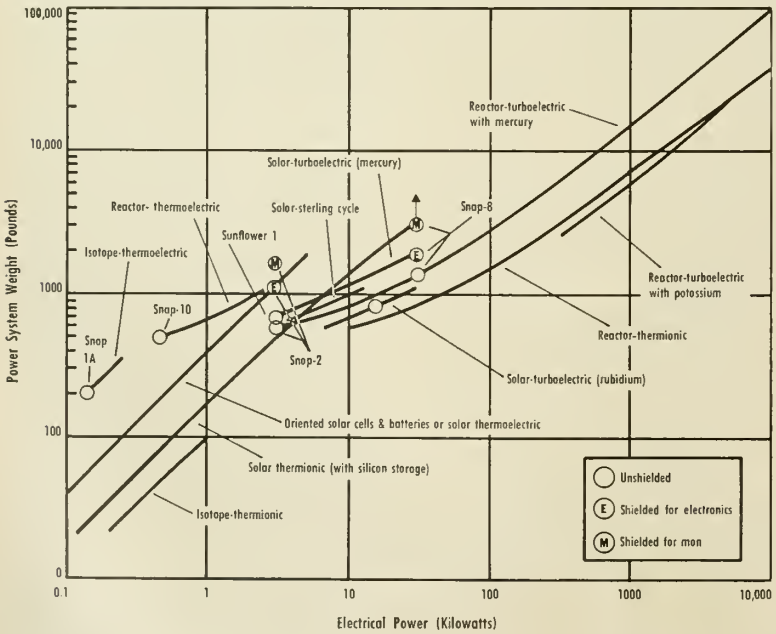
Similarly, national urgencies are involved in developing APU's able to operate offensive as well as defensive space military systems, able to power acquisition radar, computers, electronic countermeasures, and perhaps to initiate the launching of weapons themselves.

It is a truism, illustrated by the hydrogen bomb, that the military "needs" as much power as it can get.

Nearly all the space vehicles launched by the U.S. within the next several years will be getting their power from the sun. The *Mercury* manned capsule—because of its short flight duration—is an exception.

• **Needed power levels**—Through 1963, the vehicles will have power levels below 300 electrical watts. For the unmanned vehicles, this power will come from silicon solar cells feeding nickel-cadmium batteries.

The sun-orbiting satellite *Pioneer V* and the picture-taking satellite *Tiros I,* which is still transmitting, were outfitted with solar cells that developed



ESTIMATED WEIGHTS of various space power systems.

between 20 and 30 watts. The scientific satellites boosted by *Scouts* and *Deltas* had 10 watts, or less.

The *Nimbus* meteorological satellite will be getting an average power of 250 watts from a solar-cell array. For lunar-landing missions, *Ranger* spacecraft will be outfitted with more than 4000 solar cells mounted on panels which will develop a little over 100 watts.

The Venus and Mars probes, part of the *Mariner* project to launch unmanned spacecraft for early interplanetary missions, will need about 300 watts and 500 watts, respectively.

In 1965, NASA hopes to begin flight testing an electrical propulsion system composed of an ion or plasma thrust device powered by a 30-kw SNAP 8 nuclear-electric power supply.

Subsequently, NASA may call for electrical propulsion systems requiring power levels from 1 to 20 electrical megawatts. Chief use for these would be to power vehicles to explore the planets.

Every system is limited by wrinkles that must be ironed out during development time. NASA scientist William C. Cooley pointed out many of tbese during a recent panel conference at the California Institute of Technology; NASA Assistant Administrator Hugh L. Dryden and NASA scientist A. E. von Doenhoff discussed others during a meeting last month at the National Academy of Sciences. Their remarks provide some cogent observations about the state of the APU field as it affects NASA.

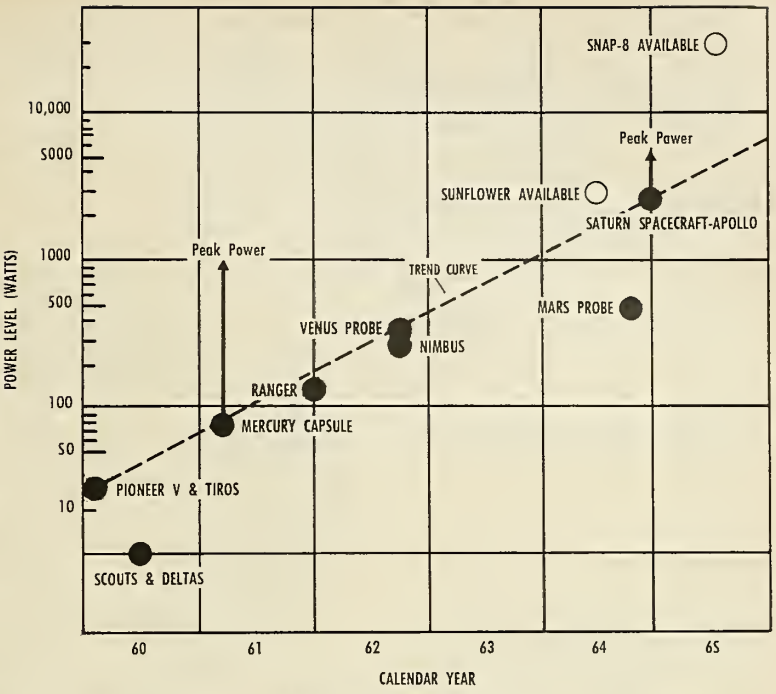
APU's get tbeir energy from three sources: chemical, solar or nuclear. Just about every advanced system will use a combination of these sources.

• **Chemical power systems**—The silver oxide-zinc primary battery offers about the highest energy per unit weight—about 50 to 70 watt-hours per pound. Unfortunately, these batteries generate gas while tbey are being recharged, and consequently do not lend themselves to space work.

The only rechargeable battery that has been used for space work is the nickel-cadmium battery, which can be sealed. However, when it is being recharged by solar cells operating cyclically as in a low-altitude satellite orbit the battery's discharge must be severely limited if long battery-life is wanted.

The nickel-cadmium battery can store approximately 14 watt-hours per pound. If for adequate battery life the discharge must be limited to 10% capacity, which is not unusual, the effective specific battery weight is only 1.4 watt-hours per pound—a far cry from its capacity.

Cooley says that a battery with greater useable energy per unit weight would be very desirable and points out that the silver-cadmium battery appears to offer some possibility.



ESTIMATED ELECTRIC POWER requirements for NASA space missions.

• **Fuel cells**—A broad research assault on fuel cells is now going on, in order to get more watt-hours per pound than batteries can give. For example, tbe hydrogen-oxygen fuel cell has a tbeoretical output of 1620 watt-hours per pound of reactants. This is the highest of any electrochemical system now known. Thus, at 60% conversion efficiency, the fuel consumption is only one pound per kilowatt-hour.

However, some of tbe problems that must be solved before fuel cells can be used in spacecraft are:

1—Acbieve long electrode life at current densities of about 100 milliamperes per square centimeter or higher, and

2—Provide for separating and removing the reaction product (water); and avoid mixing gaseous fuels into a liquid electrolyte under zero-gravity conditions.

The two most promising applications for fuel cells in spacecraft are:

1—The primary hydrogen and oxygen fuel cell, witb cryogenic storage of the fuel and oxidizer for an output of 500 watts to several kilowatts and duration of several days.

2—The electrolytically regenerative hydrogen and oxygen fuel cell, for energy storage in conjunction with solar power systems.

• **Combustion-type APU's**—The *X-15's* APU is a hydrogen-peroxide open-cycle turbine system. Such a system has a low specific fuel consumption, below two pounds per kilowatt-hour, wbich makes it highly attractive for manned spacecraft requiring several kilowatts for several days. Possible applications include the *Dyna-Soar* and the *Apollo* circumlunar spacecraft.

To avoid the limitations imposed by temperature on combustion components, NASA through a contract with Thompson Ramo Wooldridge is conducting research on magneto-fluid-dynamic power conversion. In effect, an electrically conducting plasma is expanded through a magnetic field to generate electrical current directly. The current is extracted through electrodes perpendicular to both magnetic field and plasma velocity.

• **Solar power systems**—One of the big problems with solar cells is that tbey cost so much—about $6 for the basic cell or $10 for the cell assembly. Since a square foot of solar cells will put out about 10 watts and since there are 450 cells per square foot, a kilowatt of solar cells including $50,000 for batteries would cost about a half million dollars installed.

There are two approaches that can be used to reduce the cost. The first and more obvious one is to get more power per unit cell by better solar-cell design and production.

The second way is to use geometry

(Continued on page 102)

Hard Facts On GSE Are Still To Be Developed

There's general agreement that manned space flights will bring many brand new problems—here are a few

by Hal Gettings

ASK ANY GROUP of experts what will be required for support equipment for advanced man-in-space programs and their answers are apt to be more philosophy than fact.

All agree that as boosters and space vehicles get larger and more complex the problems of transport, handling, fueling and checkout exceed the state of the art. As spacecraft go farther into space, communications and control pose new problems.

But hard facts as to exactly how development will proceed in this vital area are difficult to find. The fact that GSE development should begin at the same time and run concurrently with booster and vehicle development is indisputable. In practice, however, such is often not the case. The basic configuration of the *Apollo* spacecraft, for example, is pretty well set within certain concepts. No one yet knows, however, how the vehicle will be transported to the launch site or how it will be hauled to the nose of its *Saturn* booster.

• **Transport**—The barge is certainly a Space Age anachronism—not the ultimate answer to the transport of large boosters and space vehicles. The long time involved in getting the vehicle from its fabrication site to the launch pad, as well as the hazards en route by water, is spurring researchers to look for better ways.

At present, two possible alternatives to barge transport have been suggested: on-site assembly, and the use of blimps or balloons.

Some thought has been given to assembly—and possibly even fabrication—on-site. Since, however, the final decision is yet to be made as to where future space launches will take place—from Canaveral, equatorial bases or perhaps even from seaborne launch sites—the question is somewhat academic.

Assuming that boosters and vehicles are manufactured at some location remote from the launch site, the problem of long-distance transport may be solved by use of lighter-than-aircraft.

Goodyear proposed last year that blimps be used to transport complete booster sections. It contended that blimps could be built large enough to handle the biggest boosters contemplated. The small landing-area requirements involved, allowing pick-up and delivery at almost any location, make the concept attractive.

An extension of this idea—using balloons towed by helicopter—has recently been proposed. Ramifications of such a technique have yet to be explored, but it appears to have somewhat the same advantages as the blimp method.

General Electric scientists, in their work on the *Apollo* feasibility study, found that the technique is workable. They point out the need, however, for developing special handling fixtures for use with air transport, whether the vehicle is shipped assembled or disassembled.

• **Checkout equipment**—The complexity and magnitude of the checkout job for manned space vehicles will require more extensive use of computers and automated countdowns. The limited ground "running time" of both sophisticated electronic systems and sophisticated man will require increased checkout speed—another case for the computer-checkout marriage.

Martin Co. engineers predict that specialized one-function computers will give way to greater use of flexible arrangements of general-purpose computer modules. And ground-support equipment will be designed to permit relatively inexpensive growth concurrent with developmental refinements of the flight system.

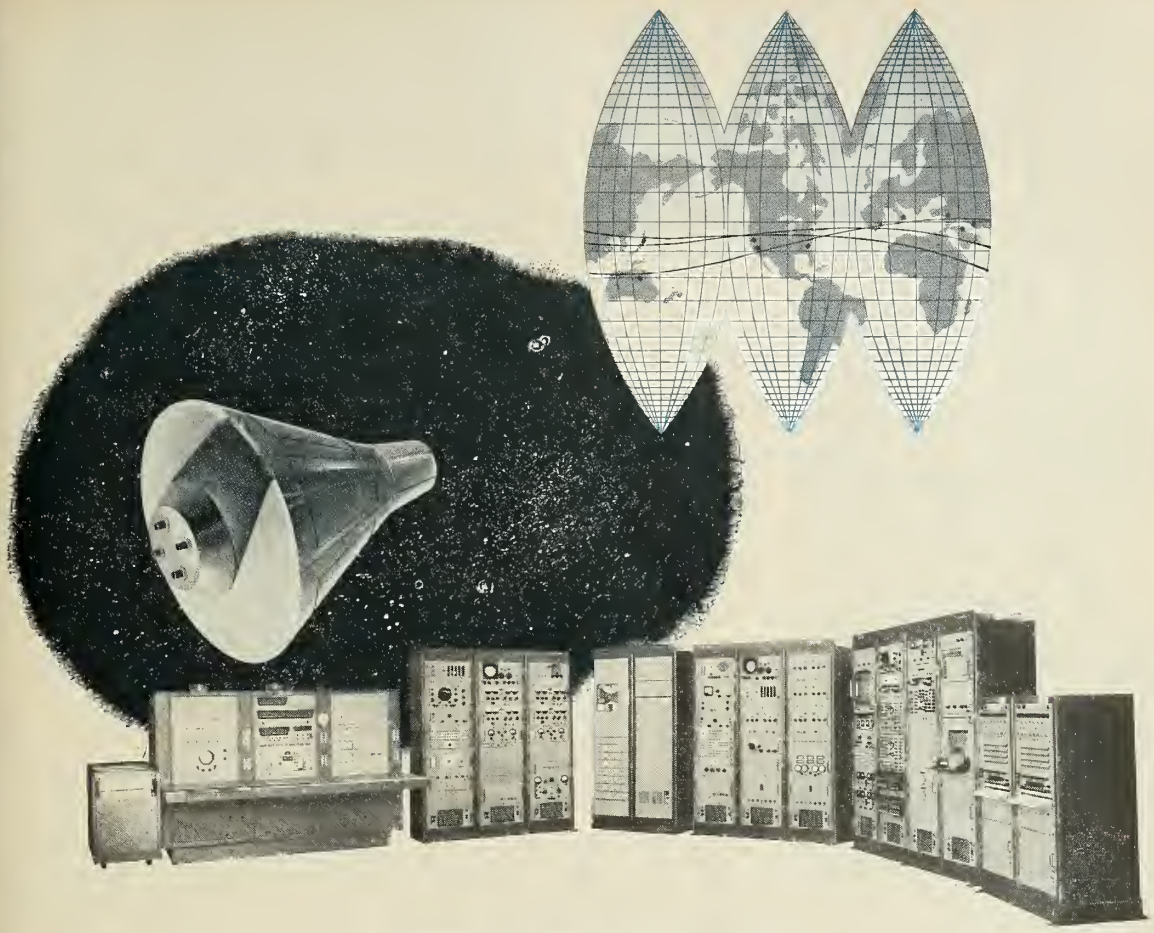
General Electric researchers back up the Martin idea. They say that the complexity of manned space systems, together with the expected multitude of changes which can be expected during development, requires modular checkout equipment with built-in flexibility.

In detailing a checkout procedure for a future manned system, GE says that the vehicle must be completely checked out before leaving the factory, down to black-box level. A duplicate checkout system will be used at the launch site.

One month before launch, there will



HELICOPTER-TOWED BALLOON may be the answer to transport of large space vehicles and boosters. Transport is a major problem in support equipment, and may have significant effect on techniques of vehicle construction.



CONGRATULATIONS TO NASA AND MERCURY ASTRONAUT ALAN B. SHEPARD, JR.

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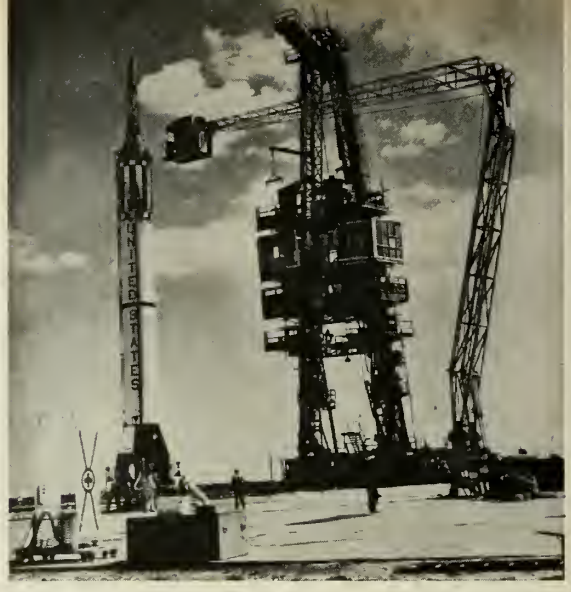
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be a checkout on the pad for complete electrical and mechanical systems compatibility—with and without flight crews.

(The vehicle will be treated much like an aircraft and have assigned ground crew and several flight crews.) During this phase, flight crews will go through series of simulated flight sequences.

After the compatibility checkout the vehicle will be returned to hangar for major checkout. Then, three to four days prior to launch, it will go back to the pad, mated with its booster, and be given a pre-flight checkout with countdown by an alternate crew. Life-support facilities are then checked out and cabin atmosphere purged.



EVACUATION CABIN on 112-ft. mobile tower provides Mercury astronaut with emergency escape between gantry withdrawal and launch. Similar equipment for Apollo, requiring a tower with twice this reach, may demand new design approach.

The flight crew—after cabin atmosphere preconditioning—will take over two to three hours before launch.

The gantry will be moved away one-half hour before launch, and the system will go on internal power.

• **Ground handling**—Facilities for handling vehicles and boosters at the launch site will be decidedly more complex than present equipment. Some items will have built-in capability to accurately measure weight and balance of final stages and the complete vehicle. A single unit will be used to weigh and measure center-of-gravity eccentricity along longitudinal and radial planes.

Ground cooling requirements for *Apollo* have not yet been determined, but the system conceivably could include everything from thermal blankets to very large air-conditioning systems. In addition, pressurized gas servicing units will be needed.

The problem of propellant handling is seen as not much different from that of today's systems. Bigger tanks don't necessarily need bigger pumps. Some problems may arise in fueling the *Apollo* space vehicle's propulsion package if the decision is made to use liquid propellants.

Major headaches in fuel handling are foreseen, however, when future systems go to nuclear engines and auxiliary power units.

• **Tracking and communications**—Facilities for tracking and communicating with space vehicles of the *Mercury* and *Apollo* types are pretty much already in existence and pose no new problems.

As presently envisioned, *Apollo* will use the *Mercury* network with some additions and modifications. The net will be supplemented with field tracking radars improved in power, reflector size, etc., for increased range.

After the vehicle is beyond 1000 miles, NASA's deep space instrumentation facility (DSIF)—with 85-ft. receiving antennas in California, Australia, and South Africa—will be used to track and communicate with the vehicle. At least one of these stations—located 120 degrees from its sisters on the earth's surface—will have *Apollo* vehicle in sight at all times.

Pending outcome of a recent study as to technical and economic feasibility, NASA hopes to extend the capability of DSIF by construction of three 250-ft. antennas at the same locations. These would give a tenfold increase in information rate from lunar and interplanetary space vehicles.

Use of England's Jodrell Bank antenna—which tracked *Pioneer V* out to 22.5 million miles—is not contemplated in future space programs. For one thing, its optimum frequency (100-400 mc) is too low for more efficient space communication. For another, it would not be available for needed lengths of time.

Deeper-space flights beyond *Apollo* will put more of a burden on communications and tracking facilities. NASA says, however, that the increased requirements will be met by development and installation of higher-capacity facilities at existing tracking sites. Major



NASA'S DEEP SPACE Instrumentation Facility includes three 85-ft. antennas like this one at Goldstone, Calif. Tracking net may later be augmented by three 250-ft. antennas to support manned space flights and instrumented probes.

R&D effort will be in improvement of communications efficiency and data-handling techniques, and continued development of more sensitive receivers (paramps and masers) and higher-gain antennas.

Programed extension of capabilities to meet these new demands can, however, be provided by evolutionary development; no revolutionary jumps are anticipated, or needed.

The choice of radio frequencies for space exploration is one without severe limitations. The basic radio range equation allows a wide range of frequencies for space communications. Dr. Eberhardt Rechtin, DSIF director, says that the state of the art in electronics and interference characteristics will probably decide the final choice of frequencies. He concludes that the range between 1 and 10 gc appears to be best. International telecommunications experts have informally agreed on the allocation of the 2300 mc band for deep-space communications. ⁂

NASA Fills a Gap

A NEW OFFICE, to bridge the gap between study projects and development programs for advanced launch vehicles, has been established by the National Aeronautics and Space Administration.

John S. Attinello, who has been chief of Scout-class vehicles, will head the new group, which will be called the Office of Experimental Development.

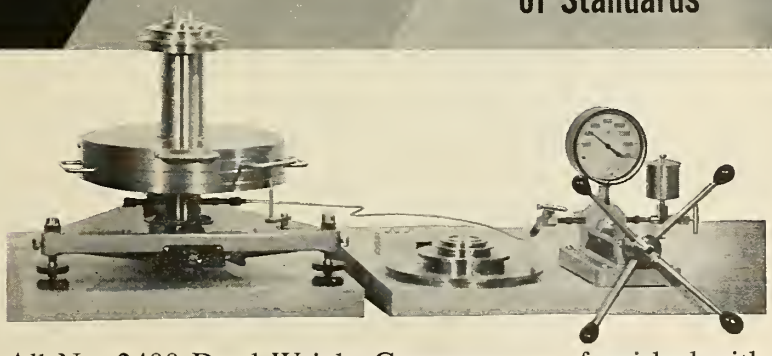
The new office will be responsible for planning programs for the Reactor In-Flight test (RIFT) vehicle, which will be designed to flight-test the Nerva nuclear engine; orbital docking and rendezvous operations; and the test programs involved in developing booster recovery techniques.

The Experimental Development office will be part of NASA's Office of Launch Vehicle Programs, headed by Maj. Gen. Don R. Ostrander. Attinello will report to Col. Donald H. Heaton, assistant director for vehicles.

Vincent L. Johnson, the Delta vehicle program manager, will take over Scout vehicles as well.

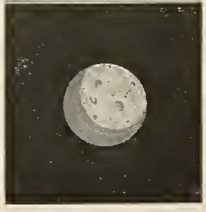
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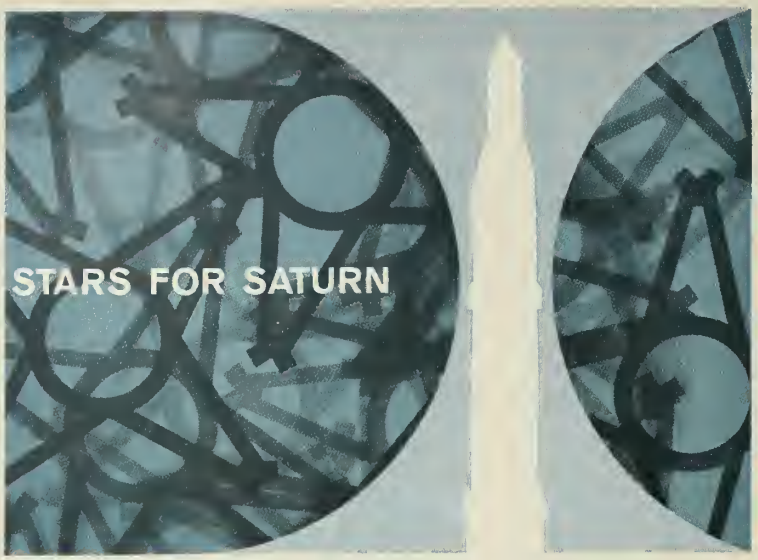
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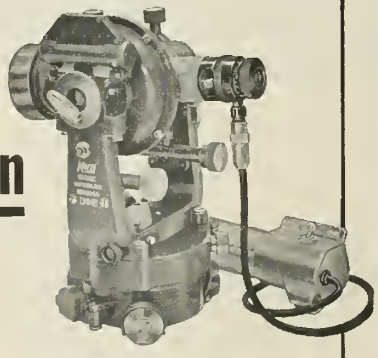
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AF's Pilot School Lacking Space Trainer

EDWARDS AFB, CALIF.—The Air Force will face two major problems next month when it begins its first full-scale course in Aerospace Research Pilot training at the Experimental Test Pilots School, AF Flight Test Center, Edwards AFB, Calif.

First the Air Force would like to have a "space trainer"—possibly some type of a ground-launched vehicle which could simulate launch, flight, re-entry, and other elements of a typical manned space flight mission in a compressed time period on the order of 10 to 15 minutes.

The second, slightly less serious, concern is an apparent lack of earth-bound simulation devices to provide basic knowledge of typical manned space vehicles. Some excellent simulators are being built, but nearly all have been designed for specific programs, rather than general application.

Maj. J. P. Seigler, assistant commandant and director of operations and training for the pilot school, and William Schweikhard, a research engineer on the school staff, say that the space trainer would remove training limitations imposed by the need to use the school's modified F-102 and F-104 aircraft. There are restrictions on the extent to which operational aircraft may be modified to provide re-entry simulation, weightlessness, energy management and landings with lift-to-drag ratios of 2.0 and 2.5:1. All these subjects and techniques will be included in Flight Training, one segment of the proposed four-part aerospace course.

• **No real answer**—Schweikhard noted that it was proposed some time ago that a two-place *X-15* be used as a space trainer, but he said this approach does not really provide the answer. In the suggested *X-15* design the instructor-pilot in the rear seat would be relatively "blind" during flight operations. Furthermore, lengthening the *X-15* fuselage to accommodate the second cockpit might pose stability problems whose solution might cost more than development of a "realistic" and simple space trainer—perhaps rocket-propelled.

An air-launched vehicle similar to that proposed for early *Dyna-Soar* testing might be another approach.

Other flight training in the "prototype" course will include time in the Wright Air Development Division C-131 used for for weightlessness studies.

School officials are quite frank in admitting that the first course will be

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a "cut-and-try" operation, but they hope they are on the right track. This is what brings up their second concern—simulation.

Simulation is a second portion of the four-part course. Schweikhard said it is a most important part of the training, despite the difficulty in determining and obtaining an adequate facility.

• **Stop-gaps**—For next month's initial class, two devices are being put together at Edwards. One is a cockpit simulator developed from a reclaimed F-102 cockpit. An analog computer, obtained as "surplus" from another Edwards facility which is updating its equipment, will be coupled to the simulator. The computer will act as an input, enabling a student to "fly" under a number of variables.

The second major simulation device will be the old "iron cross" used by the National Aeronautics and Space Administration in reaction control development. This will be modified to an air-bearing mount and fitted with simple compressed-air reaction controls. Cold gas jets, stabilizing wheels and other systems may be added later.

For other types of simulation, the school hopes to use a centrifuge, but it is not yet certain which one will be made available. Some tentative agreement has been made with the Navy to use the Johnsville facility, but the Edwards school is concerned over possible conflicts with other programs which might delay scheduled use of the centrifuge.

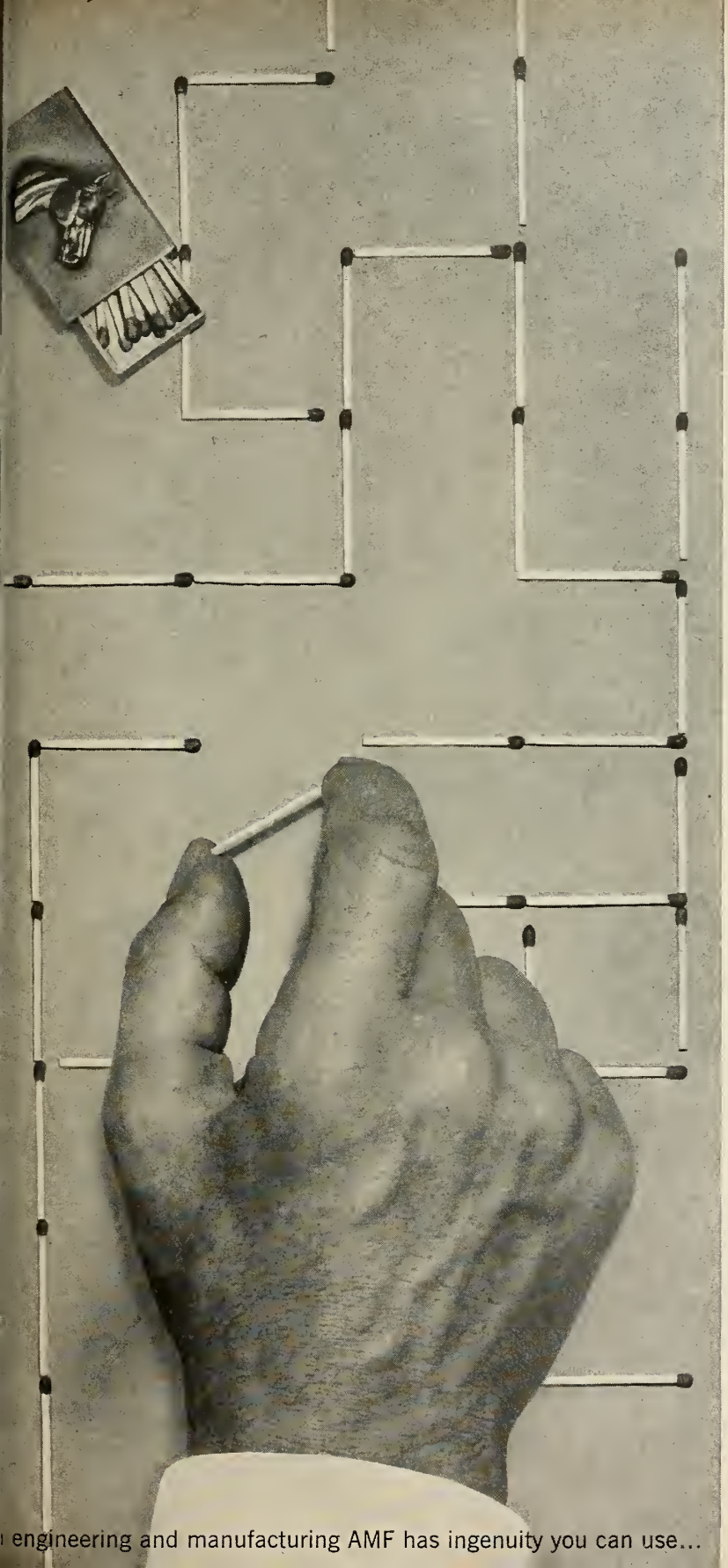
Both Seigler and Schweikhard expressed hope the program will be able to use the new centrifuge being built at NASA's Ames Lab. This would eliminate costs and time of travel to Eastern facilities. No firm agreement has been made with Ames, but school officials said they expect some cooperation.

In addition, Ames has several types of motion simulators which could be very valuable for the aerospace course.

The balance of the four-part course will consist of Academic and Field Trips.

• **In the classroom**—In the Academic phase, students will be instructed in basic subjects and areas beyond their current ability to practice and use. Subjects to be covered will include orbital mechanics, atmospheric and space physics, space navigation, guidance systems and guidance technology, launch and ascent trajectories, vehicle dynamics and communications—both voice and data transmission. Emphasis will be placed on the differences rather than similarities between aerospace operations and "normal" high-performance aircraft operations.

• **On the road**—Field Trips will consist of visits to various missile, rocket and aerospace firms where stu-



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Developed by the Sperry Semiconductor Division, Norwalk, Connecticut, this logical element is currently being utilized at Remington Rand Univac for use in future computers. It is a Sheffer Stroke circuit, using semiconductor integrated networks (SEMI-NETS*), and is fabricated from a single block of semiconductor material, using precisely controlled processes of oxide masking and solid state diffusion.

Photo at left is actual size.

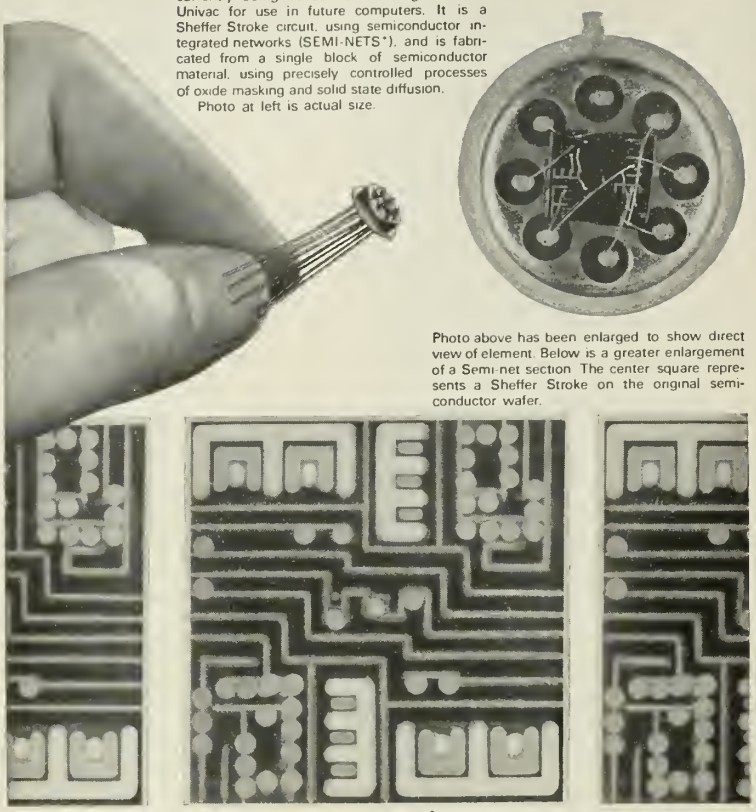


Photo above has been enlarged to show direct view of element. Below is a greater enlargement of a Semi-net section. The center square represents a Sheffer Stroke on the original semiconductor wafer.

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dents will receive briefings on special programs and current technology.

Students for the aerospace course will be selected from U.S. graduates of the Test Pilots School (the school also trains pilots from foreign countries). Following graduation, students will be sent to the School of Aviation Medicine at Brooks AFB, Texas, for special testing. It is planned to include reactions to g-loads and other types of high stress, barium tests and detailed physiological examinations.

To establish control data for the medical phases, several groups of graduates from past pilot classes of the school have been sent to Brooks AFB. Most of the biomedical studies are based, at the moment, on anticipatory-type examinations developed for the *Mercury* program. But the Air Force says that physical requirements for the course are "most tentative." Many probings will probably be dropped, and others added, as more actual data is gathered from additional ballistic or orbital manned flights.

• **High standards**—Little difficulty is expected in obtaining instructors. The first class, if present planning works out, will provide the cadre of instructors for future classes. Four of the first six students will be instructors from the pilot school.

Much of the written material has been developed from *X-15* test data. One of the most difficult tasks in planning background material is continuous scanning of pertinent literature. Close liaison with aerospace industries is expected to help in keeping all material current.

• **Toward specific jobs**—Much thinking behind the new course is based upon the Air Force's announced intent to place personnel in specific programs at the earliest possible time. With this approach, the service believes it can do a far better job in human factors and systems planning than is being done at present.

But it needs personnel, highly qualified and trained, for these assignments. Most recent such move is the assignment of three Air Force pilot-engineer officers to Boeing for the *Dyna-Soar* project—although individual pilots for the manned glider have not been selected yet, according to Major General John W. Carpenter III, AFFTC commander.

Training of such personnel is the school's mission. Personnel for *Dyna-Soar*, *Apollo* and other projects will almost surely receive their basic aerospace indoctrination at Edwards.

The school, in present planning, will not train for a specific program. It will, however, use all possible data-feedback from specific projects as material in future courses. ⁂

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Reading clockwise: Venus, Moon, Mars. Approximate distance from Venus to Earth, 25,000,000 miles; from Moon, 240,000 miles; from Mars, 50,000,000 miles.
Photos courtesy of Mount Wilson and Palomar Observatories.

Panama theory . . .

Have We One Good Reason to Colonize

GE space analyst believes there are many reasons to go into space—and offers a striking theory

by Dandridge M. Cole

IN SPITE OF the successful suborbital flight by Alan Shepard, Russia still has a long lead in manned space flight.

What is the importance to the United States of Yuri Gagarin's orbital flight, and what is the significance of the Russian lead in space boosters and manned space vehicles? Is this just a question of national prestige—important as that may be—or are there perhaps other reasons why we should be seriously concerned over our present inferior position in the manned space flight race?

We cannot answer these questions without making carefully reasoned estimates of the probable long-range future progress of manned space flight. If manned flights into space in the next thirty years will be severely limited in quantity and in extent, then the importance of man in space can properly be considered in connection with its effects on national prestige and pure science, only.

If, on the other hand, Gagarin is truly the Columbus of Space as Khrushchev has prophetically named him, and if his flight is really the beginning of a new age of exploration and colonization, then far more is at stake in the space race than even our international reputation as the top technological power.

Is it possible that there are in space areas such as "Seward's Icebox" (Alaska) which may look very inhospitable and worthless now but could become extremely valuable in the future? Could we obtain some extraterrestrial real estate now for a finite though high cost which will be unavailable at any price in the future, when its value is perhaps more generally appreciated?

• **Ballet and plans**—To answer these questions we must put forth our best efforts in long-range planning, trend research, and state-of-the-art extrapolation. Although even our best efforts will not provide answers of high reliability, *they will provide answers* and these will be better than the pure guesses we often depend on in making major national decisions.

Unfortunately, Russia leads the U.S. not only in ballet, certain Olympic events, and space boosters, but also in long-range planning. While we used to scoff at their Five Year Plans, we now must note with chagrin their superior foresight in emphasizing ballistic missile development immediately after World War II.

Our present inferior position in long-range missiles is the direct consequence of the unimaginative and *incorrect* estimate of the importance of ballistic missiles which we made in the 40's. We escaped disaster in spite of our lack of foresight (we hope) only because of an unprecedented rapid development of ICBM's and a fortuitous breakthrough in large solid rockets.

We are in serious danger of making the same mistake again with man-in-space. It is essential that we assess the probable future of space flight with full realization that excessive conservatism and technological caution may be even more dangerous than overoptimism; that technology will grow at least as fast in the future as in the past, and that new scientific and engineering breakthroughs are inevitable.

No better evidence of our excessive engineering conservatism need be considered than the fact that *all* of our major parallel weapon developments have been successful. With a reasonable factor of risk some should have turned out to be impossible! (Note in particular the *five successful* methods for separating fissionable material under the Manhattan Project, *Thor-Jupiter, Atlas-Titan,* etc.)

Then what is a reasonable estimate of the long-range future of man in space? Is it reasonable to talk about bases or colonies on the moon and the planets or are such things just romantic nonsense?

• **Extraterrestrial colonies**—Colonies on the moon and the planets are *sense* rather than *nonsense* if three conditions can be satisfied. These are: (1) the bioastronautic condition, (2) the economic space transportation condition, and (3) the desirability condition.

These might be called the necessary and sufficient conditions for establishment of extraterrestrial colonies, since it is necessary that all three be satisfied in order to establish colonies, but they are sufficient because nothing else of major consequence need be considered.

The bioastronautic condition needs little discussion beyond a brief description, since it is generally accepted. It states simply that man will be able to live and work safely in the space environment. We will eventually learn to protect men from radiation, meteorites, temperature extremes, prolonged low gravity, etc., if such things prove to be serious hazards.

The low transportation cost condition is not quite so generally accepted, perhaps because the studies on future low-cost space systems have not had adequate distribution.

Obviously, colonies on the moon and the planets would be economically unattractive if payload boosting costs remained at their present high levels of several thousand dollars per pound in orbit. However, there are excellent reasons for believing that these costs will drop drastically in the next 20 to 30 years. It should be noted that there is no disagreement on this point among those who have made and published careful studies of the future space travel cost question!

We can expect in the next 20 years the direct operating cost of soft landing one pound of payload on the moon (Fig. 1) will drop from something on the order of $5000 in 1965 to $500 in 1970, $50 in 1975 and $5 in 1980. At this point the indirect operating costs will become an important factor and the

)uter Space?

curve of total cost will start to level out.

• **Energy misconception** — At the present time, it costs close to $5 per pound to fly to Australia. A large part of this cost (about 75%) is "indirect"—employee salaries (40%), materials, supplies, services, food, etc. These costs should be approximately the same for the moon flights and will not change much with time.

Direct operating costs are primarily those of the vehicle and the propellants. They represent the necessary investment for satisfying the energy requirements.

It is commonly believed that the energy requirements for space flight are far beyond anything ever attempted in earth transportation systems. This is one of the most serious misconceptions concerning space flight. Actually the energy required for a round trip to the moon is no greater than that for a round trip to Australia!

We have then an engineering problem of designing efficient and economical space systems which will perform as well in space as our present systems perform on the ground or in the atmosphere. We need larger vehicles which can be recovered and reused, and we probably want to use nuclear propulsion for at least part of the flight.

Some of the systems which have been proposed for very low-cost space travel are the *Rita* nuclear vehicle—Douglas, *Orion*—General Atomic, *Aerospace Plane*—USAF, and the contained nuclear explosion system proposed by the writer. There are also a number of other interesting possibilities which could almost certainly lead to low-cost systems if selected for development.

Of course, low cost alone will not bring about colonies on the moon. There must also be a good reason for establishing the colony. But note that only *one* good reason need develop, and this reason might be in any one of a number of different categories.

Some of the more important general categories in which we may find this major motivating force are:

(1) The challenge—adventure—men against nature category.

(2) Racial survival (if something happens to the earth like an all-out war).

(3) Science—the possibility for major scientific breakthroughs on entering new realms of nature.

(4) Economic—new sources of raw materials when earth supplies are depleted by exploding population.

(5) Military—retaliatory forces with reduced base vulnerability and increased warning-decision-reaction time.

(6) Social political—the possibility for growth of our culture through long-range colonization of new worlds.

This is only a partial list of reasons for colonies in space. There are many others. And remember that we only need *one* good reason!

• **The Panama Theory**—The Panama Theory can be summarized in one paragraph.

There are strategic areas in space—vital to future scientific, military, or commercial space programs—which must be occupied by the United States, lest their use be forever denied us through prior occupation by unfriendly powers.*

This is simply another way of saying that the history of exploration and colonization of the western hemisphere, Africa, and Australia, will be repeated in space.

No one can prove that the Panama Theory is true at this time, but the important point is that it *could* be true. Even if its probability of truth is quite low we should make sure that our space program represents adequate "life insurance." Most analysts agree that an all-out war is very unlikely; yet we spend billions on warning systems, air defense, etc., which do not help to pre-

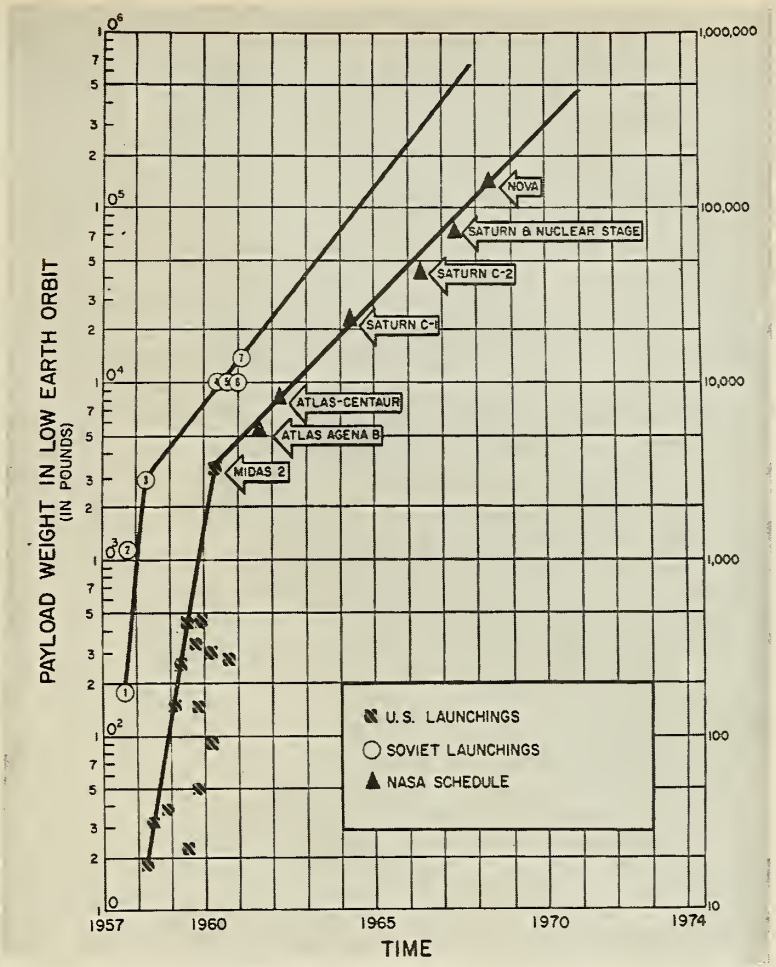


FIG. 1 Russia will widen "Booster Gap" if rocket development rate continues. Note straight line growth from Sputnik 4 to Sputnik 7.

* *The word "forever" is used in the sense that a criminal who is imprisoned for life is deprived of his freedom to roam the earth "forever," even though he is not in jail for an infinite time.*

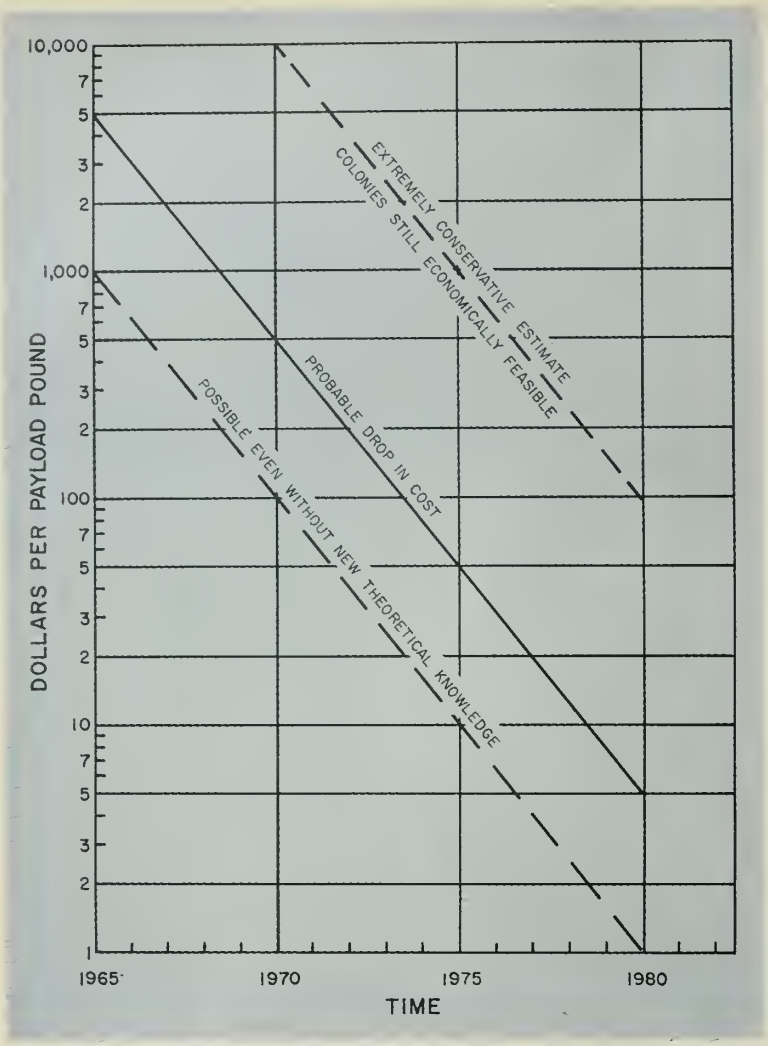


FIG. 2 Sharp drop in payload per lb. costs are expected in next 20 years. Reason: energy requirements are really low for moon trip.

vent war and will only be of value in the unlikely event that war occurs. Likewise we should spend enough to at least match the Russians in space and preferably outdistance them, to counter even a small probability that they might gain some decisive advantage. But is it just a small probability?

There are only two serious questions about its truth, if the preceding argument for extraterrestrial colonies is accepted.

These are the questions of "preferred" or "strategic" areas and the question of continuation of the power struggle.

Suppose that mankind does establish colonies on other planets. Will this be done in a framework of friendly cooperation with other nations, or will competition be the rule as it has been almost invariably in the past?

It is often noted that Russia has cooperated with us in the Antarctic. This is true. But there are three points to remember in this connection. (1) We were there first. (2) The Antarctic is not a stepping stone to any new worlds. (3) The Antarctic is, superficially, relatively homogeneous—one big icebox. The competition may start when the key areas are discovered!

In short, the Russians cooperate when it is to their advantage to cooperate. If they discover a rich source of high-grade uranium in the Antarctic, will they offer to share it with us? We are on roughly equal footing with Russia in the Antarctic and reasonably well equipped to compete if competition proves necessary. Will we be so advantageously situated on the moon?

The remaining question is that of preferred or strategic areas. Are there any in space, or is all the extraterrestrial real estate as relatively homogeneous as the Antarctic now appears to be?

Almost certainly the key strategic areas of the moon and other extraterrestrial bodies are yet to be discovered, but it has often been noted that the moon itself can have a unique value in the future conquest of the solar system.

The moon may be—in a sense—a Panama Canal.

Because of its low gravity, and perhaps its lack of atmosphere, it can become an excellent refueling station for vehicles making longer space flights. Note that this depends on the availability of propellant materials on the moon. There would be no value in carrying earth-manufactured propellants all the way to the surface of the moon for refueling Mars-bound space ships!

However, it is easy to show the advantage to a military commander of a fleet of nuclear deep space patrol ships if there's a source of liquid hydrogen on the moon. Likewise it would be much easier to refuel a nuclear vehicle bound for Mars or beyond, with hydrogen from the moon than from the earth.

Of course this depends on our finding a source of hydrogen or some other expellent material on the moon. Only two or three years ago the general scientific opinion was that there was no hydrogen or water on the moon.

• **Water on moon**—Now, after more careful consideration, a number of scientists have predicted that water in the form of water of crystallization in the lunar rocks is almost certain to be found. One estimate indicates that as much as one percent of the lunar surface may be water.

While this is far less than the percentage of water on the earth, it nevertheless represents a very considerable tonnage. Harrison Brown, Harold Urey, V. A. Firsoff, I. M. Levitt, Zdenek Kopal and Thomas Gold are among those prominent scientists who have very recently predicted that water in substantial quantities would probably be found on the moon.

The moon is a big place, and a Russian base complete with propellant-manufacturing plant would not necessarily preclude a similar operation by the U.S. The questions here are the availability and distribution of the best-grade hydrogen ores (not necessarily water) and the Russian lead in establishing moon bases.

Suppose that the Russians land on the moon five years ahead of the U.S. In this period it would be possible to establish several bases and stake out a claim to the whole moon. Of course, they would say that the moon was the property of all men and they were only holding it temporarily. And of course, the state will someday "wither away"

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In the meantime, however, any attempt by the United States to land on the moon would be declared aggression and our space ships would be shot down.

With only a two-year lead, the Russians might take possession of both the lunar poles—the most likely place to find water in the form of ice. Obviously, there are many other materials and natural formations (caves?) which are more likely to be discovered by the first ones on the scene. It is important that we do not give Russia a possibly critical advantage in time by failure to compete in the space race.

Of course, some say that we are not behind Russia in the overall space effort and that it is only in the area of payload weight that they have a lead. Unfortunately, high payload weight capability is the first requirement for a successful manned space flight. And in both these areas they obviously have a very substantial advantage.

• **The Booster Gap** — President Kennedy was recently quoted as saying "regardless of how much money we spend on *Saturn*, we are still going to be second. . . ." This is not immediately obvious, since *Saturn C-2* is being designed to orbit 45,000 lbs. of payload as compared to the 14,000 lbs. payload of *Sputnik 7*. Why won't this three-to-one advantage put us in first place?

The answer is that *Saturn C-2* is not scheduled for operation until 1966 and that, regardless of how much money we spend, we cannot advance this date to earlier than about 1964. However, 1964 is only three years away. Is it reasonable to expect that Russia will increase its payload capability by a factor of three in only three years?

Unfortunately, Russia may do considerably more than that. It is possible, even probable, that by 1964 they will have the capability for boosting 100,000 lbs. of payload into orbit.

Growth curves for U.S. and Russian orbital shots are pictured on Fig. 2. All the major Russian satellite launchings are indicated which contribute to an understanding of their payload capability. *Sputniks 8, 9, 10* and *11* would be off to the right of the curve and not important in this connection.

The same is true for U.S. launchings to date. Note that the curve is intended to indicate maximum capability in a given time period rather than average capability.

The curves also include some key performance figures from the 1960 NASA schedule and a possible extrapolation of the established trend in Russian launchings. Of course, the Russian curve represents actual launchings, whereas the U.S. curve beyond *Midas II* is simply a schedule—and schedules usually slip.

Of course, we do not *know* what advances in payload capability will be made by the Russians in the future. It is possible that their performance curve will level off sufficiently to strike the NASA schedule line in perhaps 1967, but this would be an extremely optimistic interpretation of the data. *Note that this graph was originally prepared in June, 1960, and that Sputnik 7 (January, 1961) confirms exactly the straight line growth curve through Sputniks 3 and 4.*

The NASA schedule of 1960 was considered to be a reasonable step-by-step evolutionary growth in booster capability. A development of this type in which each future step is determined by present status and past performance

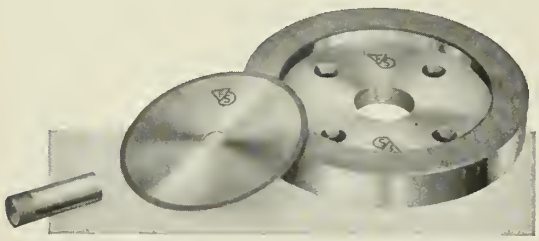
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naturally leads to a logarithmic increase as illustrated by a straight line on a semi log grid. Isn't it reasonable to assume that the Russian booster program, which has led ours by about two years ever since the late 40's, will continue on a similar, parallel, logarithmic growth curve?

The Russian schedule is believed to include a manned lunar landing by 1967. It would be reasonable to assume that in order to do this they would already have under development a *Nova*-like vehicle with early flights scheduled about 1965.

While the "step-by-step" schedule is hardly likely to close the booster gap, it would still be feasible to do so by the critical 1965-1967 period.

If we engage in a major effort to establish a moon base at the earliest feasible time, we can defend our military, scientific and economic interests in space and preserve our national honor. Even if the first manned lunar landing is Russian, we will quickly surpass them in the quality and quantity of our lunar colonization effort. ⌗

Panama Theory Poll

Dandridge M. Cole, a space program analyst in General Electric's Missile and Space Vehicle Department, has asked other persons in the space field what they think of his Panama Theory.

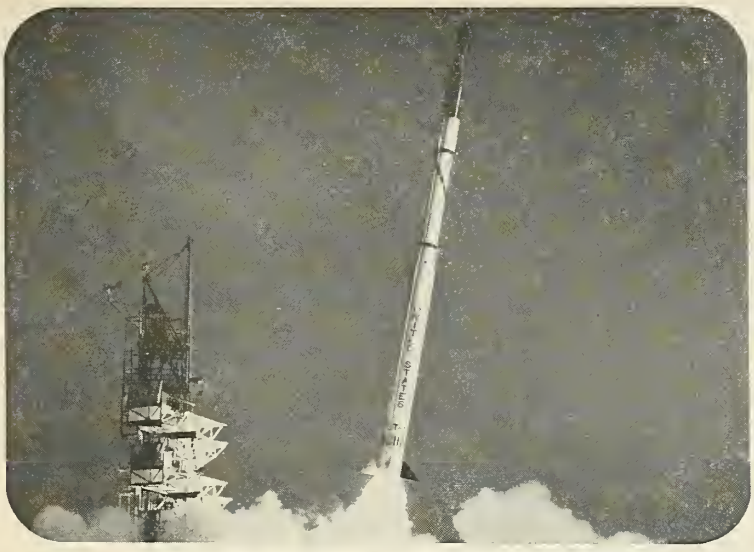
Cole polled 89 American Rocket Society Officers (34% replies), 75 high NASA officials (27% replies) and 17 editors of aerospace publications (35% replies) with the following results:

ARS—92% think the Panama Theory is a good reason for urgency and all responses average an est. 75% probability that the theory is true.

NASA—65% think it is a good reason for urgency. 56% probable that it is true.

Editors—83% in favor of urgency with 77% probability that the theory is true.

A study was made of the "non-responding group" by the Harvard Business Review in connection with similar questions on space flight and similar percentage responses. It shows that it is reasonable to assume the same distribution of opinions among the non-respondents as was found in the responding group for ARS.



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TI PROGRAMMERS IN SPACE EXPLORATION

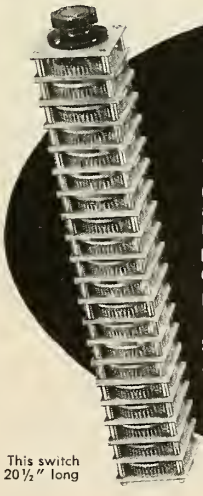
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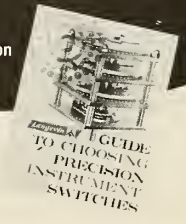
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Life Support

(Continued from page 46)

considerable research should be going into the long-term effects of breathing 100% oxygen at partial pressure. *Dyna-Soar*, and perhaps even *Apollo*, astronauts may have to be satisfied with this.

(The Russians apparently succeeded in getting sea-level pressure as early as *Sputnik V*, according to all available information.)

• **Food**—In spite of early talk about "algae biscuits," food in space will probably not be such an ordeal. The Aerospace Medical Laboratory at Dayton has been working for years on setting up low-weight, high-acceptability diets. Space dieticians now estimate that it will be possible to carry as much as a year's supply of food at a weight cost of about a pound a day.

Some new twists in refrigerating food will make it possible to carry fresh food for months. General Electric has mapped out complete feeding plans for journeys of almost any length with some unique refrigeration concepts. The company holds a contract for Project *FROST*, from the Aeronautical Systems Division, AFSC.

The Whirlpool Corp. recently completed building a prototype kitchen for



FOOD: Big item in GE's vehicle concept.

three men for a two-week voyage. While it's unlikely anything of that size or weight (818 lbs.) will be flying in the '60's the work goes a long way in pointing up all the little details which must be considered.

Faced with the danger of people cooped in with rotting garbage for weeks, the company designed some highly effective antiseptic sprays and containers. The workspace and arrangement of articles is designed with all the efficiency of a Mrs. Galbraith.

• **Protective clothing**—Probably the biggest single problem in the 60's is designing a pressure suit in which the wearer can move comfortably. The *Mercury* suit although remarkable for its pioneer effort, will not allow the pilot to make repairs or do much moving around under pressurization.

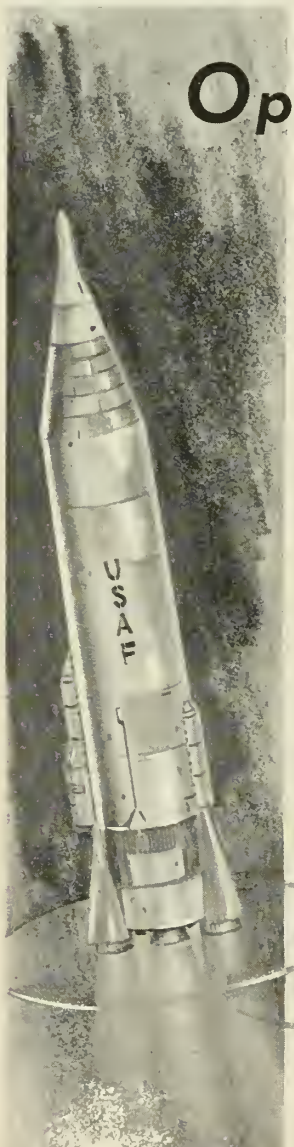
A more advanced suit designed by International Latex Corp. for the Air Force has a good degree of mobility and can be worn outside the ship except in high radiation areas. It is designed for wearing only for short periods—for launch, re-entry and emergencies. But, in spite of improvements over other suits, it still takes several minutes to put on.

The ideal suit, of course, would satisfy a chorus girl for lightning changes and an acrobat for mobility. Good tactile sense in the fingertips will also be necessary.

Another suit under development which might advance the state of the art is General Electric's Space Cape. It is highly classified, but it is known that the requirements it must meet are very rigid.

• **Bioinstrumentation**—Another field that has advanced far in the last few years, although some glaring gaps remain. The first problem is laying down the meaningful measures. Is it important to know what the pilot's skin temperature is? Do you need to record his eye movements to tell whether he is getting sick at his stomach, or can he tell you himself?

Ideally, it's best to find out everything possible about him, then pick out what's important. But, as aerospace medicine expert Lt. Col. Charles Berry says, "He's only over you for so long—and you've got to decide if he's sick o



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well and what to do about it—and in a hurry!"

The Texas Instruments *Mercury* telemetry system relays the astronaut's temperature, respiration, rate, electrocardiogram and pulse, as well as the suit pressure, temperature, oxygen and coolant supply.

The Soviets also apparently have a workable encephalograph, ballistocardiograph and perhaps even a blood-pressure sensor. Many U.S. space medicine experts say that an EEG would be a great asset in forecasting trouble of a psychological nature. A ballistocardiograph, which measures strength of the heart's muscular movement, might tell if the astronaut's circulatory system was weakening because of prolonged weightlessness.

Blood pressure is universally considered a necessary measurement. The problem has been developing an instrument that would not hinder the wearer. A pressure-cuff on the arm is cumbersome. Pressure sensors on smaller areas —fingertips or earlobes, are not always accurate. There are problems in controlling an air source to inflate any pressure device.

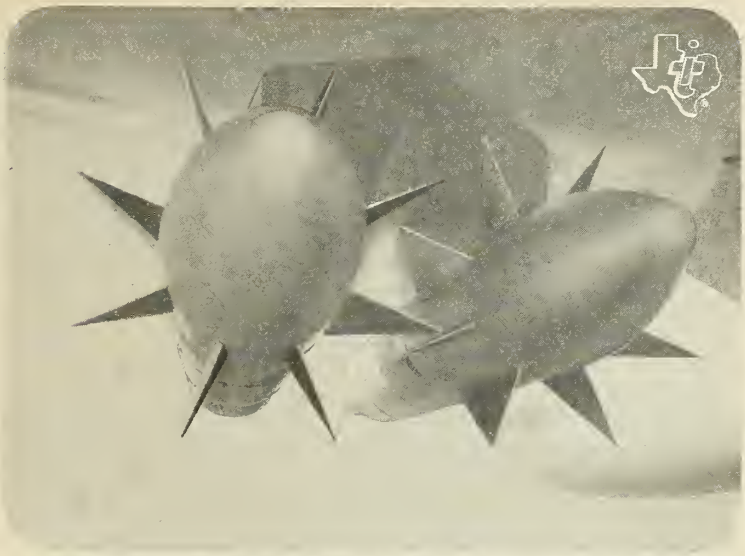
Pravda reported that for *Sputnik V* the Soviets performed pre-flight operations on the dogs and got blood pressure directly from an exposed cartotid artery. Whether the U.S. will go to anything this extreme remains to be seen. A number of companies—among them Boeing, Garrett, Spacelabs, North American, Bendix and Hughes—are developing blood-pressure sensors and several show promise of coming up with something in the next year or so.

Also in the wind are internalized telemetry systems which produce a clearer signal with less ambient noise. Spacelabs, Inc. of Los Angeles is the leader of this approach. A monkey with an implanted system is due to fly a ballistic trajectory in an *Atlas* "piggy-back pod" this July. The animal has had the system inside it for a number of months now and has had no ill-effects.

• **Psychological aspects**—The problems are as complex as the people involved. Generally a "normal" man will always run into trouble the more he is shut off from outside contact.

Careful screening of astronauts will eliminate those who would tend to go to pieces easily or can't get along with others. Psychologists also recognize that useful tasks and frequent contact with the ground will help maintain a good mental condition.

Food will play an important part in mental attitude. In some group tests at the Aerospace Medical Laboratory the subjects did little else but sit around and talk about food. In every confinement experiment the crew ate more. ⁂



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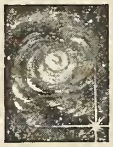
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Re-entry Approaches

(Continued from page 61)

sidered in a pre-selecting landing site, engineers such as R. L. Phillips of STL agree that atmospheric braking will be the chosen system for years to come. Today's rocket powerplants do not deliver sufficient performance, particularly in specific impulse and thrust-to-weight ratio, to make retrothrust an optimum method for significantly reducing the entry velocity.

The entry angle can be varied on low-altitude (i.e., low velocity) satellites such as the *Mercury* capsule and the *Discoverer* recovery capsule by applying appropriate reverse thrust from available solid-propellant rockets.

In the case of return from our moon or one of the planets, the entry angle can be controlled by present state-of-the-art guidance systems, entirely inboard or partially earth-located, the experts say. Of course, the ideal system would be independent of ground stations and could be used for entry through other planetary atmospheres.

Changing the entry angle can have the following effects:

- If the entry angle is 6 degrees or greater, the deceleration force on a ballistic-type capsule will generally be greater than 10 g's.
- If the entry angle can be kept small, for example, 1 or 2 degrees, the maximum deceleration can be held to levels which man can tolerate for the required duration.
- At the flat angles of 1 to 2 degrees, a small error in entry angle will result in only a small variation in maximum G-loads.
- At the typical entry angle for an ICBM, the nose cone can be subjected to a dynamic loading greater than 70 g's.

Reducing the entry angle to that compatible with man, however, increases the total aerodynamic heating and also makes landing at a selected point a more difficult problem for uncontrolled spacecraft. The thermal environment is largely caused by gaseous compression as the entry body rams down into the atmosphere. In other words, the air ahead of the body has to pass through the shock wave that is formed at the high velocity and, in the compression processes, heats the gas surrounding the affected surface.

There are two predominating types of heat transfer during this situation: (1) convective heat transfer caused by the gaseous compression and by viscous skin friction, and (2) radiative heat transfer caused by electromagnetic radiation from the hot, ionized gases behind the bow shock wave. Characteristics of the thermal environment are greatly influenced by vehicle configuration and trajectory characteristics.

- **The entry corridor**—Another parameter receiving increased attention because of the recent industry activity in the field of manned space flight is the entry corridor.

The knowledge that a satellite-type spacecraft must be capable of operating over a spread of speeds and altitudes in relation to those characteristic of a nominal entry has resulted in adoption of the corridor concept.

There is no official definition for many of the terms encountered in "3-R's" technology. Entry corridor is generally agreed to be the range of entry conditions (angles and velocities) within which an acceptable entry is possible. This parameter is sometimes called the guidance corridor because of the very great dependence upon the spacecraft guidance system to approach the atmosphere of a planet at precise angles.

A. J. Eggers, Jr., of NASA, gave a more detailed explanation of the corridor concept in "Motion and Heating of Lifting Vehicles During Atmosphere Entry." It was co-authored with Thomas J. Wong, also from Ames Research Center.

If a satellite-type entry vehicle while moving at less than satellite velocity



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passes through the upper boundary of this theoretical corridor or exceeds that altitude, the entry vehicle will be traveling too slow to sustain altitude and will be unable to check its descent before passing through the lower boundary of the same corridor.

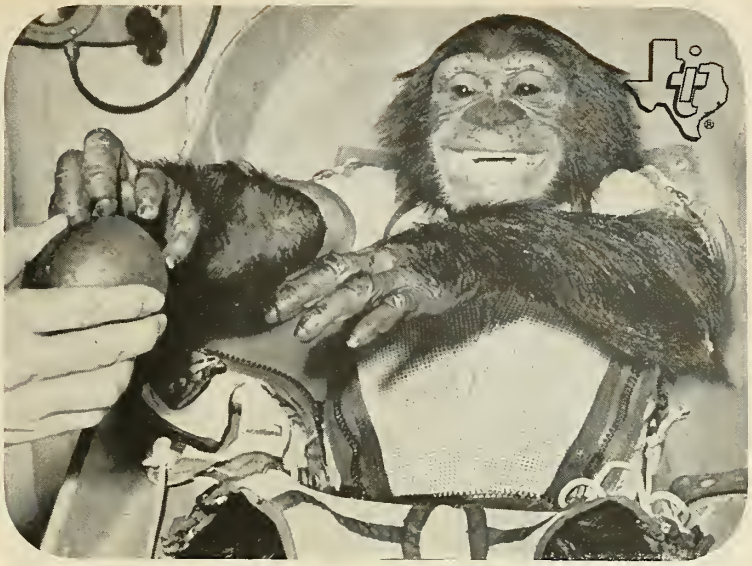
If the same vehicle at the same approach velocity passes below the lower boundary as it enters, the vehicle will be traveling too fast to maintain acceptable deceleration loads and/or heating rates.

In the case of satellite-type spacecraft, the corridor boundaries (high and low) are defined as the speed/altitude limits outside of which the spacecraft should not be entering whether in the course of returning from orbit or making an emergency landing from an aborted boost into orbit.

If a spacecraft returning from cislunar or planetary space pierces the atmosphere at escape velocities above the upper boundary of the entry corridor, the vehicle will be unable to decelerate sufficiently to avoid exiting the atmosphere. It will proceed back into space for possibly vast distances and many days. This latter result is considered to be undesirable and somewhat discouraging to the returning space crew who have post-landing plans.

On the other hand if supervelocity entry leads to flight below the lower boundary of the corridor, the velocity will be so high that the landing spacecraft will be unable to avoid excessive heating and/or deceleration.

Eggers considers the approach from another planet along a corridor made up of an overshoot and an undershoot boundary, a region that is the difference between the virtual perigees of the overshoot and undershoot conics. These are fictitious conic trajectories which could be followed if the planet and its atmosphere theoretically did not have any size but were replaced by an equivalent point mass.



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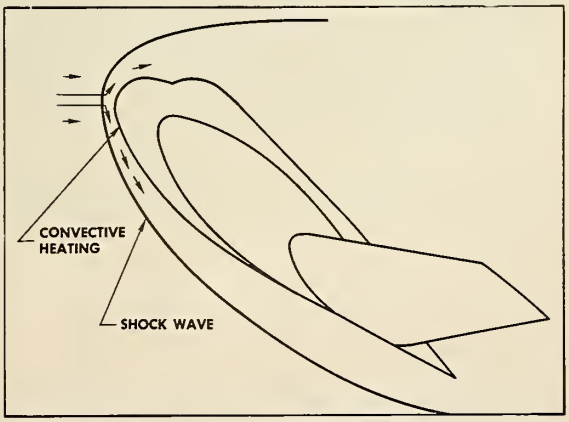
The larger the depth of the corridor, the less stringent is the requirement for guidance accuracy during the planetary approach.

• **Importance of the corridor**—Failure to approach the entry corridor at correct velocity, altitude, and angle can be disastrous. If a planetary spacecraft enters the atmosphere of a planet very steeply, say near 90°, then the dynamic loading can quickly rise to a peak of more than 400 g's. In contrast, if the atmosphere is pierced at 400,000 ft. (generally agreed to be the top of the sensible atmosphere) at less than approximately 4°, the vehicle will follow a grazing trajectory and proceed outward along a new and unexpected orbit.

All these statements can be summarized in a few words. The returning zero-type lift vehicle must be directed by a guidance system or some other arrangement to follow a precise entry angle found to be between 5° and 6°. This leaves a very tight corridor only about eight nautical miles in depth.



DOUGLAS MANNED re-entry vehicle model in position to begin landing maneuver after completing previous re-entry phases.



ATTITUDE OF the Lifting Re-entry Vehicle as it begins the transition phase in the upper atmosphere.

The narrow guidance corridor can be "opened up" by employment of one of several available techniques.

- The entry vehicle can be designed in a manner that permits its drag coefficient to be varied; a technique known as drag modulation.
- A vehicle can be designed and controlled in a manner that will produce lift.
- It is believed that an earth-entering vehicle can be designed to employ magnetohydrodynamic drag, taking advantage of the ionized boundary-layer air.

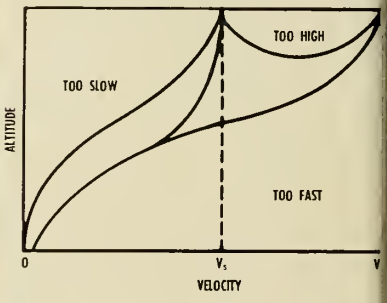
• **The drag-modulated vehicle**—Donald M. Waltz of Radioplane discusses drag modulation in some detail in his paper, "Design Criteria and Techniques for Deployment of Aero-Space Deceleration Devices." As Waltz points out, a constant value of deceleration rate can be obtained if the term made up of the density ratio divided by the ballistic parameter is held constant. The density term is the ratio of density of the atmosphere at altitude to density at sea level. The ballistic parameter, W/C_DA, has become a common term in re-entry technology. In it, W represents vehicle weight, C_D is the total drag coefficient, and A or A_c is the cross-sectional area on which C_D is based.

Lower values of the ballistic parameter for a vehicle entering the atmosphere will result in lower maximum heating rates and surface temperatures. Peak deceleration rate will be essentially unaffected by variations in this parameter.

Drag modulation describes a system where the drag area (C_DA) is continuously decreased as altitude decreases. The desirability of achieving rates of deceleration lower than those experienced during typical entry of ballistic nose cones is apparent. As the drag-modulated vehicle plunges into the atmosphere, it can be streamlined more and more by mechanical means to prevent dynamic loading from reaching more than a fraction of the unmodulated value.

If the drag coefficient can be varied by a factor of 10, the deceleration can be reduced approximately 60 percent.

• **The MHD-decelerated vehicle**—A few industrial organizations are seriously studying the feasibility of an advanced technique for increasing re-entry drag—the use of magnetohydrodynamic principles. It is known that a large portion of the boundary layer air flowing over an entering body exists in the ionized state. This condition results from the high-velocity, high-temperature, low-density flight regime in which the body is traveling prior to and during atmospheric entry. Ablation of surface material tends to increase this ionization.



GRAPH illustrates Corridor Concept.

The ionized boundary layer will conduct electricity and can be forcibly shifted by a magnetic field. The MHD vehicle can slow and deflect the ionized gas flowing over the vehicle by means of a magnetic field. The field is produced by passing a heavy current through a ring surrounding the body at the appropriate location.

The electromagnetic drag force will result from giving the body a larger effective cross-sectional area as far as pressure drag is concerned. The shock wave would correspondingly be moved upstream and thereby would reduce the heat transfer rate.

Proponents of this concept are reported to be looking for a lightweight



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municipal power station that can be fitted into a spacecraft.

• **The lifting re-entry vehicle**—The entry corridor depth can be increased by employing negative lift along the upper boundary and positive lift along the lower boundary. The first alleviates exiting or climbing out of the upper atmosphere; the second avoids penetrating to too low an altitude at too high a velocity.

Thus the vehicle continues to travel at very high altitudes (i.e., in low-density gas) until it decelerates to the condition from which it can proceed to lower altitudes without developing great drag forces. A considerably wider range of entry angles is thus acceptable.

The linear tolerance on the guidance system corresponding to this technique is increased to approximately 80 nautical miles, compared to the 8 nautical miles previously stated. Of equal importance, a lifting vehicle can be used for a certain amount of maneuvering during flight in the terminal region to assist in landing at a designated field.

The Douglas concept, labeled "A Practical Manned Entry System," resembles a blunt delta wing; the vehicle incorporates a thick-wing, subsonic airfoil modified to satisfy hypersonic thermodynamic requirements.

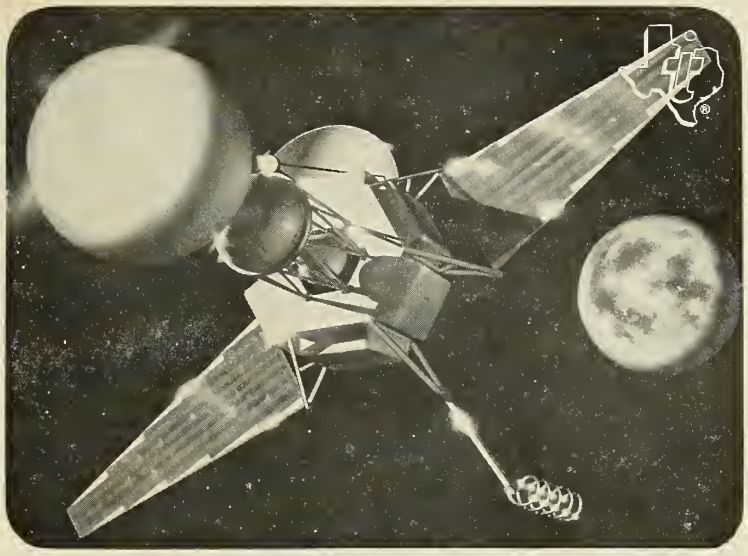
The thick wing was chosen to give the vehicle adequate subsonic flight characteristics and to reduce hypersonic heating. The wing section chosen has a profile similar to a forward-camber subsonic profile. The platform is best described as a modified trapezoidal which presents a blunt stagnation region at high angles of attack. A vertical stabilizer rises from each wing tip. The spanwise contour provides a small angle of effective dihedral for lateral stability at subsonic speeds.

A sharp trailing edge improves the control capability and provides better subsonic lift. Model tests indicate that a maximum subsonic lift/drag ratio in excess of twelve can be attained; a maximum lift coefficient greater than 1.4 was measured within the angles of attack of interest.

• **Entry of the lifting vehicle**—After the Douglas wing approaches the planet's atmosphere along a coasting transfer trajectory characterized by the particular mission, entry technically begins. At approximately 400,000 ft., aerodynamic braking commences.

The orientation given to the wing to obtain lift during entry must be carefully controlled to keep the dynamic loadings within the passenger's endurance while at the same time not subjecting the structure to unacceptable heating.

During interviews with Lowe, du-Pont and Gervais, M/R learned that altitude-controlling and maneuvering in



RANGER III — National Aeronautical Space Agency space vehicle for a United States lunar probe — uses digital command decoder developed and built by TI for the California Institute of Technology and Jet Propulsion Laboratory.

TI DECODERS IN SPACE EXPLORATION

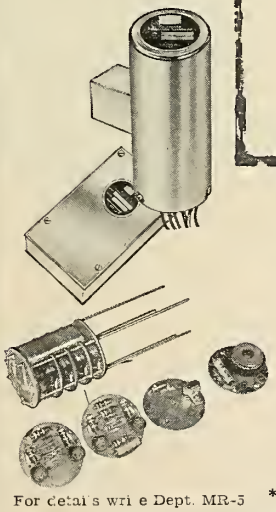
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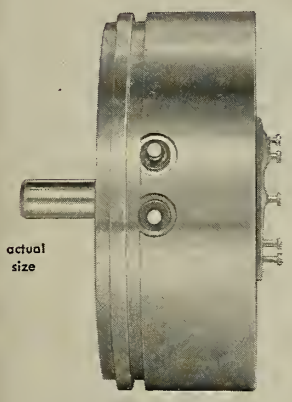
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the upper atmosphere and during the approach will probably be accomplished by some arrangement of fixed thrusting nozzles, perhaps similar to the *X-15* installation.

They found that their wing should be designed to enter the atmosphere at the angle of attack that corresponds to the maximum lift attitude—because the deceleration loads will be within the pilot's tolerance and the surface heating will be minimized at this orientation. The Douglas engineers analyzed four methods of placing the lifting vehicle on an equilibrium glide trajectory—constant-attitude entry, modified lift-modulated entry, two-phase injection entry, and an entry that makes use of a rolling maneuver—and selected the latter.

Prior to attainment of the equilibrium glide, the calculated trajectory is characterized by three distinct phases—entry, transition, and constant-altitude phases, in that order. During both satellite and planetary entries the wing is maintained at constant lift (maximum lift attitude) through the pullout altitude where maximum heat rate is encountered. Reductions in lift prior to this event will increase heating.

Consequently, the wing will start the transition phase at approximately 45 degrees angle of attack along a positive flight path angle of 0° to 2°. Next a pitch-down maneuver must be executed, reducing the lift to an eventual negative value, to keep the vehicle in the atmosphere if the entry is at planetary velocity. For satellite entries the pitch-down maneuver prevents phugoid oscillations.

The method by which the designers plan to decrease lift without heating both sides of the wing is the unique feature of this concept. By means of attitude-control jets (probably in an autopilot loop) the wing will be rolled about its velocity vector in such a manner that the total angle of attack (45°) along the flight path is continuously maintained.

By this rolling maneuver, the vehicle's effective lift in the vertical plane is reduced but the total lift is relatively unchanged. The deflection in lateral range would be accounted for in the landing prediction. The advantage of this concept is that only the bottom of the wing is exposed to hot gas flow and needs to be thermally protected.

The rolling maneuver is continued until a roll angle is found that causes the flight path angle to go to zero value at an acceptable altitude to initiate the constant-altitude phase. Here the purpose is to dissipate remaining kinetic energy at safe temperature levels until the velocity is reduced to a value where the equilibrium glide can be attained.

In maintaining constant altitude the vertical lift will need to be gradually increased as the vehicle's velocity de-

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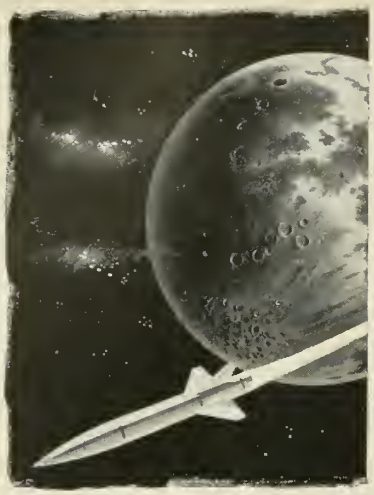
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creases or, in other words, the roll angle must be correspondingly decreased. The high total angle of attack is continuously held throughout constant-altitude flight, ending with the roll angle again at zero. Now all lift is confined to the pitch plane.

When this condition occurs the wing has been decelerated to less than satellite speed and will start to descend again, this time along an equilibrium glide path.

As the wing progresses into the glide phase, velocities of 15,000 to 22,000 ft. per sec. are anticipated. Therefore, the maximum lift orientation must be held as the vehicle descends through the atmosphere to a point where a high angle of attack is no longer mandatory for thermodynamic protection. Then the remaining energy can be used to obtain additional range if needed and to execute the landing maneuver.

There are many concepts of lifting re-entry and planetary entry vehicles under study and, in a few cases, in test. It is too early to foresee what configuration will follow *Dyna-Soar*, the first space glider. ⁂

Guidance & Control

(Continued from page 73)

will have to be built and tested.

• **Simulation results**—Martin-Baltimore has performed extensive simulations for *Apollo* and for determining manual controllability of spacecraft for space rendezvous. Its system duplicates all guidance aspects of space travel, and the company has to date accumulated millions of miles of simulated flight. Similar programs have been conducted for *Apollo* feasibility studies by General Electric, Convair, and others.

Since the *Apollo* vehicle will be under the complete control of its crew, every aspect of manual control has been simulated.

In the rendezvous studies, Martin said results have shown there is no doubt that even with a relatively simple, lightweight guidance system space rendezvous can be accomplished. The controls in the simulator, which in function and performance closely emulate those actually to be used, permitted velocity control down to increments of 1.5 ft./sec.

Other simulations have proved the feasibility of orbital injection, midcourse guidance, re-entry and landing at a designated point, and degree of radiation hazard with varying protective shielding.

A major point is this: Based on a variety of inputs to M/R from leading manufacturers, the consensus is that no breakthroughs are necessary in techniques or equipment for G&C for



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manned orbital or circumlunar flights. There will be development problems—as in any major prototype system, but now it is a case of building and integrating with present hardware, not a matter for researching.

• **Current R&D**—The stakes are high in this race by manufacturers to secure a winner in each new space event. As far as G&C systems are concerned, here is a glimpse at what some of the other leaders are now doing:

—As *Dyna-Soar* vehicle prime, Boeing's chief concern has been the specification and integration of guidance and control into the space system. Current efforts are toward integration between primary and radio backup boost guidance, development of a satisfactory energy-management scheme to accomplish re-entry, and the development of glider flight control and secondary guidance systems. Boeing also is making an intensive study of space vehicle attitude control and rendezvous.

—Raytheon is pushing development of injection and orbital guidance and navigation techniques, using inertial platforms with star trackers and horizon scanners.

—Martin, among its many programs, is waging a development battle against excess size, weight, and cost of complex G&C systems. Also, it is attempting new approaches for stability and control by employing new self-adaptive techniques.

—RCA, also attempting to lessen excess weight and power in manned space vehicles, is employing micromodule fabrication techniques for hyperenvironment computers. It has another program to study the designs for various non-rotating, expandable guidance computer memories.

—Douglas is performing comprehensive studies of the whole control problem. Research is being performed in the analysis of a new adaptive control system employing a supervisory controller which adjusts system gain as a function of control surface effectiveness. This system, says Douglas, is unique in that it eliminates the requirement for air data measurements and calculations. In very-high-performance systems, where stagnation temperatures in excess of 1500°F may be encountered, serious material problems can be by-passed if air data probes are eliminated, the company said.

Methods of controlling large flexible missiles by ignoring elastic dynamic effects (by heavy filtering) and substituting computed high-frequency response also are being studied. These will provide a means of attacking the control problem of an aerodynamically unstable airframe in a dynamic wind shear environment, where high control gains are required. Other special control problems being studied include control of disturbing torques from atmospheric, solar, micrometeorite, gravitational, magnetic, and internal movement effects of manned vehicles operating in cislunar and interplanetary space.

—Nortronics is continuing its development of highly advanced stellar-inertial guidance systems. One, the A-5 astronertial navigation system, reportedly is 0.1 the size and 0.05 the weight of its predecessor in *Snark*. The system is a stellar-corrected, velocity-damped inertial package capable of accepting relatively poor initial condition data and yet provide maximum accuracy, according to Nortronics.

Another, the A-11, will be further minified. Now two years in development, it will be an all-attitude four-gimbal inertial system having, the company says, "the highest order of perfection yet achieved." ⌘

Auxiliary Power

(Continued from page 75)

to gain more power per unit cell—that is, by concentrating more solar power on each cell. This means that solar cells would be working in higher power ranges than they are now.

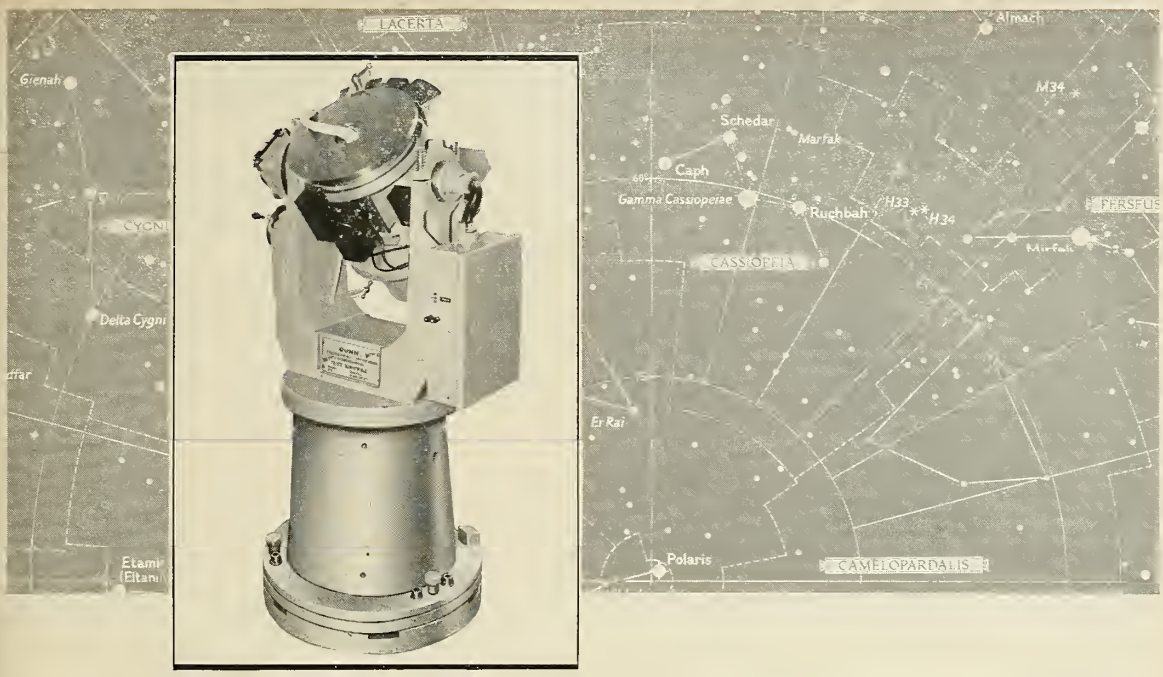
For this purpose, mirrors might be used to concentrate the sun's energy on a large solar-cell panel. Care must be taken to avoid overheating the cells and thereby loosing them.

A program is currently being initiated at Jet Propulsion Laboratory to look into this approach. JPL is also encouraging a modular solution to the problem, so that banks of solar cells can be added or subtracted according to the power required.

The Air Force is also known to be letting contracts on the solar-cell problem. Major companies working on the solution are Electro-Optical Systems and Boeing.

• **Thermal energy storage**—There is obvious interest in finding a way to store thermal energy in a compact unit which will operate a heat engine continuously when the spacecraft is passing in the shadow of a celestial body. One promising way is to store energy as the heat of fusion of a material whose melting point is higher than the heat input temperature to the heat engine. When the material entered the shade it would freeze thereby releasing its heat of fusion to operate the engine at a constant output. Accordingly, a high value for the heat of fusion is desired.

Cooley points out that lithium hydride is good for heat engines operating below its melting point of 682°C. Soldium fluoride may be considered for use with boiling-liquid metal cycles



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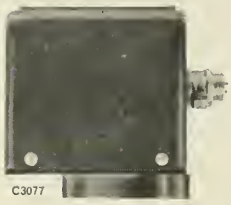
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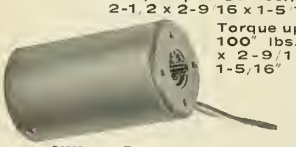
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(such as rubidium or potassium) or Brayton gas-turbine cycles at temperatures up to 992°C.

The beryllium-silicon eutectic appears suitable for cycle temperatures up to 1089°C. Molten beryllium, and particularly silicon, would be desirable for use with thermionic converters having cathode temperatures below 1350°C and 1420°C, respectively.

• **Solar-mechanical systems**—Three types of solar-mechanical power systems are now being developed—a 3-kw-output mercury-vapor turbine system, a 3.8-kw Sterling engine system, and a 15-kw rubidium-vapor turbine system.

The 3-kw system is being developed under NASA contract by the TAPCO Group of Thompson Ramo Wooldridge. Called "Sunflower," the system consists of a foldable petal-type solar collector that will open to a diameter of about 32 ft. The sun's rays will boil liquid mercury which will drive a turbogenerator to produce electric power. The thermal energy storage unit will permit continuous operation, even when the craft is in the earth's shadow.

Sunflower is being designed for possible use in spacecraft launched by *Centaur* and *Saturn* vehicles.

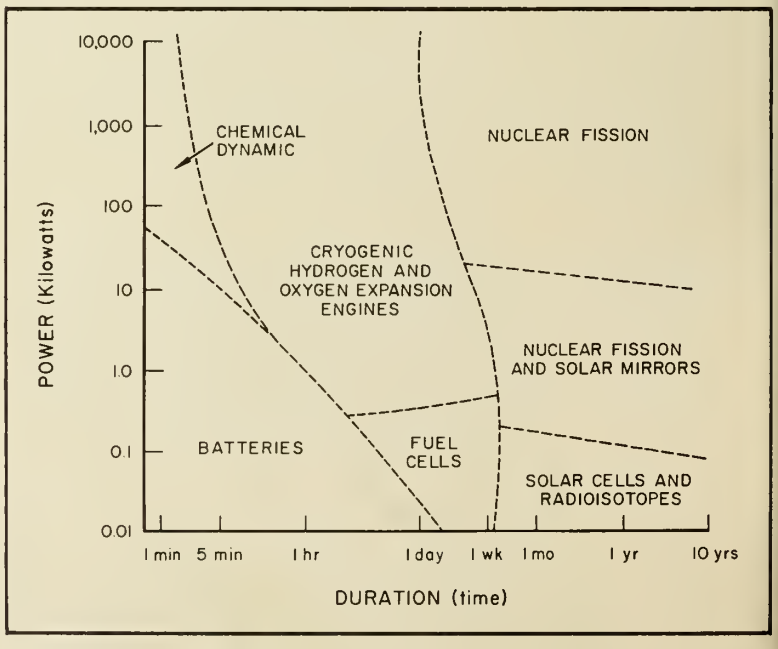
The Sterling engine is being developed for the Air Force by the Allison Div. of General Motors. Its high thermal efficiency—over 30% as compared to 11% for the Sunflower mercury Rankine cycle—makes it quite attractive because of the reduced size and weight of the collector and thermal storage system.

Nevertheless, the Sterling engine's disadvantage is that the low temperature of the cooling water (150°F to 250°F) requires a large-area radiator, not easily packaged into a spacecraft.

The 15-kw rubidium-vapor system is being developed for the Air Force by the Sundstrand Turbo Div. Although the high turbine-inlet temperature of 1750°F, with a radiator temperature of 675°F, will potentially yield a lightweight system (819 lb), there are still serious material problems to be solved involving a thermal storage unit and a lightweight solar collector.

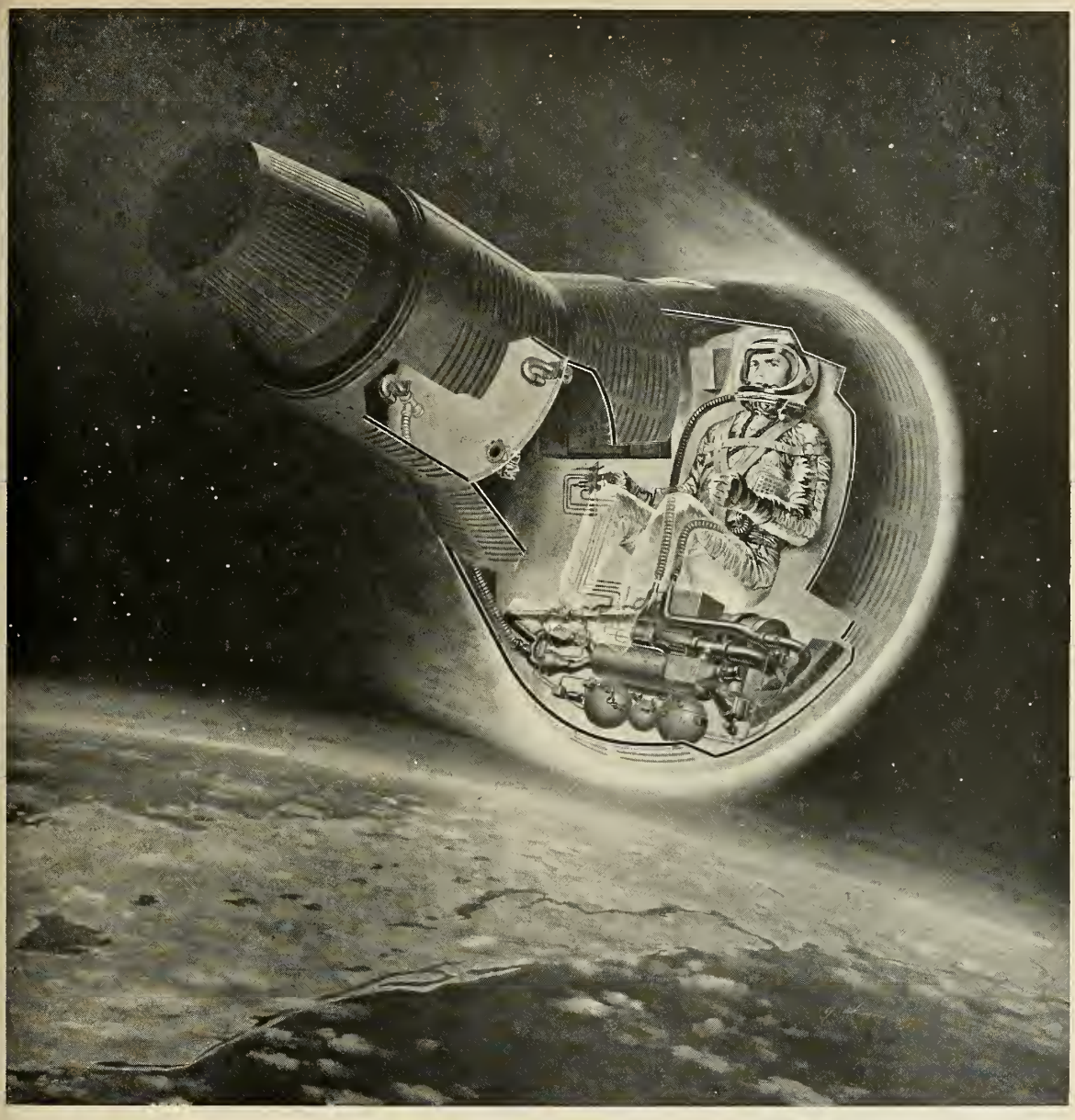
• **Solar-thermoelectric systems**—Thermoelectric materals have been getting much attention from the Navy because of their possible use in static cooling systems for nuclear submarines. In addition, modular cooling of electronics through the thermoelectric effect is far more inviting than through mechanical systems (M/R, October 31, 1960, p. 22).

Currently, there are two feasibility contracts on solar-thermoelectric systems under way at Systems Command, Wright-Patterson AFB. The first, which involves a flat-plate solar collector, is held by General Atomic Div. of General Dynamics; and the second, involving a small parabolic collector, is held by Hamilton Standard. The major disadvantage of solar-thermoelectric systems is the large area of solar collector



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and radiator required per unit of electrical output; this is the result of the limited efficiency of presently available thermoelectric materials.

• **Solar-thermionic systems** — The Missile & Space Vehicle Department of General Electric has a Systems Command contract for a 500-watt solar-thermionic electric power system. A feasibility demonstration of the unit will shortly take place at Phoenix, Ariz. Called the "STEPS" system—an acronym for Solar Thermionic Electrical Power Supply—it uses a parabolic collector to focus the sun on a spherical array of thermionic converters.

JPL is in the process of letting a contract for a solar-thermionic module capable of putting out 130 watts.

• **Nuclear power systems**—NASA does not plan to use any nuclear APU's for manned space flight in the present decade because of shielding problems, lack of redundancy in many instances, and because of the relatively short duration of the planned flights. Nuclear APU's do not show to large competitive advantage until flight times begin exceeding one month.

The SNAP units are the most well known nuclear APU's (M/R, August 22, 1960, p. 39). SNAP-3, a thermionic-isotope device developed by the Martin Co., produces six watts and weighs just under a pound. It can be used for unmanned deep-space probes and soft lunar landings.

SNAP 2, 8 and 10 are the three space nuclear - reactor electric - power units that the Atomic Energy Commission is currently developing for NASA and the Air Force through the Atomics International Div. of North American Aviation.

The SNAP-2 system is designed to generate 3 kw of useful electrical power continuously for one year. A flight-capable version of this system will be delivered to the Air Force in 1964.

The SNAP-8 device is a larger version of SNAP-2. It will produce 30 kw with one power conversion unit and 60 kw with two power conversion units coupled to the same reactor. NASA has announced that if the system works it will be used for such purposes as long-life communications and electric propulsion devices. The first SNAP-8 experimental reactor will go critical early next year; AEC expects the flight tests will be conducted sometime in 1965.

The AEC describes SNAP-10A as a system that will demonstrate the capability of the SNAP reactor powering a thermoelectric converter located in the vehicle's skin. The reactor is about the same as in SNAP-2, but the converter in the system will put out 500 watts. AEC expects the flight-testing of SNAP-10A to take place sometime in 1963. ⌗

Spacecraft

(Continued from page 43)

The weight penalty involved in *Dyna-Soar's* wings was a major factor in the recent decision to switch from *Titan I* to *Titan II* as a booster. *Titan I* is able to lift 3000 lbs. into a 300-mile orbit, while *Titan II* will have a capacity of 8000 lbs. But the Eisenhower Administration starved development of the glider so that it wouldn't be ready until *Titan II* was ready, anyway.

• **Timetable**—Even with the time lost, *Dyna-Soar I's* first flight is still expected to be one to two years ahead of the three-man *Apollo*—assuming *Apollo* becomes a program. With *Titan I, Dyna-Soar* flight tests were to begin in early 1963. The exact timing of both *Dyna-Soar* and *Apollo* depends on funding decisions to be made by the Kennedy Administration and Congress.

Dr. Wernher von Braun, director of NASA's Marshall Space Flight Center, has said that the *Saturn C-1* will be ready for manned flight by the end of 1964 or early 1965. If *Apollo* and *Dyna-Soar* are pushed as fast, it may be possible to fly them on early earth-orbiting missions during that period. *Dyna-Soar's* suborbital flight could come in late 1963 or early 1964 if *Titan II* is ready by then for manned flight.

Saturn C-1 will have orbital payload capacity of 19,000 to 20,000 lbs., which will provide plenty of margin for the orbiting *Dyna-Soar*. For orbital *Apollo* flights, the *Saturn C-1* will be able to lift a three-segment spacecraft.

The basic *Apollo* unit will be the command center, weighing about 10,000 lbs. For the orbital mission, a 2500-lb. propulsion module will provide attitude control, some orbital maneuverability for rendezvous experiments, and retropropulsion capability to reduce the velocity by 500 fps for return from orbit.

A third segment will be the so-called mission module weighing 7500 lbs., which will provide a second room for living space and to conduct orbital experiments. The mission module will be separated prior to re-entry and will remain in orbit.

Although NASA has decided it cannot afford the weight penalty involved in giving *Apollo* a glider shape, with a relatively high lift/drag ratio, the spacecraft will have aerodynamic control surfaces and thus will not be a purely ballistic body. *Apollo's* lift/drag ratio will be between 0.4 and 0.7—compared with 2 or more for a *Dyna-Soar* type glider.

• **Apollo's shape?**—The modest amount of lift plus control surfaces will allow the *Apollo* crew to vary their landing point by upwards of 1000 miles

longitudinally and by a few hundred miles laterally. However, the final descent will be made by parachute, just as with the *Mercury* capsule.

By comparison, a craft with lift/drag ratio of 2 can vary its longitudinal range up to 9000 miles from orbital velocity. Its lateral range can be varied up to 2500 miles.

The *Mercury* capsule itself has a lift/drag ratio of 0.4. However, the lift is not utilized because there is insufficient heat protection on the afterbody. With high-temperature materials, the *Mercury* capsule shape becomes one candidate for *Apollo*.

The accompanying illustration shows five basic shapes that were considered in the *Apollo* studies recently completed by NASA contractors. The two at the left—the glider and the circular lenticular body—have high lift/drag ratios and high resulting weight penalties that have caused their rejection. The other three are still in the running. The *Mercury* shape is represented at the lower right.

The second version of *Apollo*, designed for the circumlunar mission, will have only two modules, the command center and an expanded propulsion module. *Saturn C-2* is to have the capacity of launching 15,000 lbs. to escape velocity. The basic command center will remain at 10,000 lbs. but the propulsion module will rise to 5000 lbs.

The corridor for re-entry from the lunar flight will depend on the lift/drag ratio. A purely ballistic flight would have a re-entry corridor 8 miles wide. With a lift/drag ratio of 0.4, the width rises to about 40 miles. However, the curve flattens and the additional corridor width attained with an L/D ratio of 0.7 rises only to 45-48 miles.

Many elements of the basic *Apollo* command center would be used for the later lunar landings. Plans are still based on total weight of about 10,000 lbs., although some obvious structural additions would be required to set down on the lunar surface. The major difference will be in the propulsion module. To provide retropropulsion for soft lunar landings and liftoff for the return to earth trajectory, about 200,000 lbs. altogether must be boosted to escape velocity.

There is some possibility that the three-module design might be followed for the circumlunar vehicle. If the weights can be shaved down enough, a separable mission module might be included, so that only a relatively light re-entry vehicle might come in from the circumlunar flight. However, that decision will not be made in the design of the first *Apollo* for the orbital mission.

• **Apollo modules**—Of the 10,000 lbs. weight in the *Apollo* command



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Comparison of Apollo and Dyna-Soar Spacecraft

	Apollo Orbital	Apollo Circumlunar	Dyna-Soar I Suborbital	Dyna-Soar II Orbital
Crew	3	3	1	1
Weight	20,000 lbs. in orbit 12,500 lbs. re-entry	15,000 lbs.	About 10,000 lbs.	About 10,000 lbs.
Booster	Saturn C-1	Saturn C-2	Titan II	Saturn C-1—Closs.
Shape	Lifting body	Lifting body	Glider	Glider
Lift/Drag Ratio	.4 to .7	.4 to .7	2 or more	2 or more
Landing Method	Parachute	Parachute	Like jet aircraft	Like jet aircraft
Aerodynamic Control	Limited	Limited	Complete	Complete
First Flight Scheduled	1965-66	1967-68	1963-64	1964-65

center, NASA figures that structure, heat protection and related systems will weight about 6000 lbs., life support and occupants will weigh 2500 lbs. and the 400 kilowatt-hour power supply will weigh 1500 lbs.

The command center will be a cylindrical segment 10 to 15 ft. in diameter and 6 to 8 ft. long. The mission module would be slightly smaller, with volume equivalent to a 7-8 ft. cube.

The major difference between the overall design of *Apollo* and the *Mercury* capsule would be on the afterbody. *Mercury* has protection against re-entry heating only on the blunt face. Its afterbody exterior consists of shingles made from a nickel-cobalt alloy capable of withstanding tempeartures in the 2000°F range. The *Apollo* afterbody probably will have ablative materials. However, there is a possibility of exotic metals.

The propulsion module will have the capacity to change the velocity by 1000 to 2000 fps for rendezvous experiments in the orbital mission. For the maneuvers required to steer the spacecraft around the moon, about twice that capacity will be necessary.

The largest single problem in the design of the *Apollo* spacecraft is re-entry. The first phase of the work will be a series of basic investigations of materials and shapes at Mach 40—over a period of several months, and possibly up to a year or more. Then several likely shapes will be tested in vertical flights, first with *Scout* vehicles and later with *Atlas-Agena B.*

• **Must head for port**—Navigation is complicated by the constant necessity of "escape." Even when the mission is well on the way to the moon, there is a requirement of capacity to turn around and scoot for home. For there are no plans to carry heavy radiation shielding. *Apollo* will depend on solar "weather forecasting" and schedule its flights when no flares are expected.

The clouds of protons and electrons spewed by solar flares are no hazard to the early *Apollo* orbital flights, which will be below the lower edge of the Van Allen radiation belts. The earth's magnetic field will prevent the proton clouds from penetrating that close.

For the circumlunar flights, NASA plans to rely heavily on predictions based on a technique developed by Kinsey Anderson of the State University of Iowa. The Anderson technique, by studying sunspot penumbra, makes it possible to predict with fairly high



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certainty that a solar flare will not occur in the next few days. Others believe similar predictions can be made on the basis of sudden variations in the earth's magnetic field.

So far, no one has claimed the ability to predict for a period of seven days, the length of a circumlunar flight. Thus there remains the possibility of a warning of solar activity after the flight is under way.

Industry calculations indicate that with 6000 fps retropropulsion capability it might be possible to return to earth within 40 to 50 hours when halfway to the moon. However, the craft is not likely to be carrying more than about 4000 fps propulsion—enough for return in about three days.

The best solution would be a close watch on the solar weather both before and during the flight, so that the on-board propulsion might be used for the reversing maneuver if signs appear that the sun will be acting up soon.

For radiation shielding, the plan is to make maximum use of equipment and supplies that must be carried anyway. For example, the water supply will be carried in flat tanks that will cover much of the interior. A bit of shielding material may be spotted about to fill holes left by the on-board equipment.

The Air Force program calls for prototype *Dyna-Soar* re-entry tests launched by *Blue Scout* rocket vehicles next year. The full-scale glider will be tested in airdrop flights from a B-52, similar to the *X-15* launching technique.

The *Dyna-Soar* re-entry problem is quite different from that of a drag vehicle like *Mercury* or *Apollo*, which re-enter in five to eight min. and encounter g loadings up to 10 or more. The *Dyna-Soar* takes 30 min. to an hour or more for re-entry and the g loading is much lower. On the leading surfaces and edges, the heat-transfer rate is less than the drag vehicle, but because of the large surface involved, the total amount of heat is greater.

Cooling methods under consideration include radiation, ablation, fluid injection, heat sink, active fluid and magnetohydrodynamic. Considerable test data is needed before the final decision is made on a method or combination of methods.

The best guess on the material choice probably is graphite for the hottest portion, backed up by a somewhat stronger ceramic material. Behind the graphite-ceramic combination would be a high-temperature metal with even greater strength for the basic structure. If such a combination does not get rid of the heat fast enough by radiation, some sort of circulating fluid method will probably be adopted.

(Continued on page 113)

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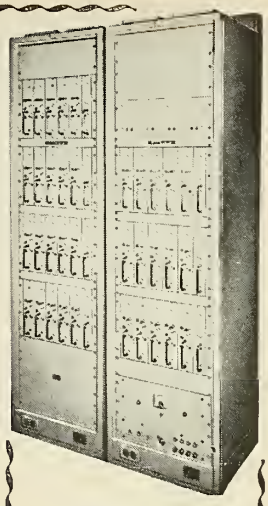
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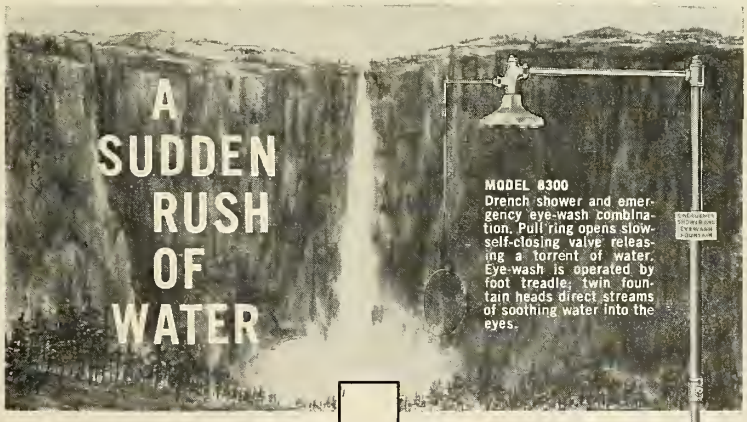
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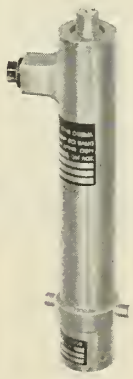
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soviet affairs

By Dr. ALBERT PARRY

Who built Gagarin's rocket?

This question must have been asked of the Soviet cosmonaut, by foreign journalists at least. For in a recent article, "The World in One Hundred Minutes," in *Izvestia* the Major declared: "The world does not as yet know the names of those who built the cosmic rocket, and the time to know has not as yet come."

Yuri Gagarin thus echoes Nikita Khrushchev's famous dictum of July 9, 1958, in a speech to factory workers at Bitterfield, East Germany. The Soviet boss said then that Soviet "scientists and engineers working in atomic and rocket technology," although well paid and otherwise privileged, "have to suffer somewhat in only one respect: for the outside world they are, for the time being, anonymous."

On that occasion Khrushchev went on: "We highly value these people, we prize them and protect their safety from hostile agents who might be sent to destroy these outstanding people, our valuable cadres. But now, in view of the safety of the country and of the lives of those scientists, engineers, technicians, and other specialists, we may not as yet make public their names and their photographs."

Nearly three years

have passed, but the policy still stands. Compare this secrecy with the many proud advertisements rushed into American print by companies describing in photos and words the contributions they made to Commander Shepard Jr.'s rocket and capsule. Add to this the numerous interviews, both published and televised, with the American scientists and engineers responsible for these contributions, and you have one more illustration of the contrast between the open society of the West and the closed world of the Communist East.

What about foreign observers?

I asked this question on the morning of April 12, a few hours after the news flash about Gagarin and his *Vostok*. It was addressed to Professor Leonid Sedov, the Soviet astrophysicist, as both of us appeared on Dave Garroway's NBC television program "Today." I pressed: Will the Soviets allow foreign observers to be present at the next landing of a Russian cosmonaut? My implication was that secrecy was hurting the Soviets, that because of it not all the people in the world would believe their rocketry claims.

Professor Sedov replied that he could not promise invitations to foreign observers for the very next Soviet cosmonautic launching or return, but that in the near future such invitations might be possible—provided there is a relaxation of general international tensions.

The Moon, Mars, and Venus

are Major Gagarin's future destinations. This was revealed in his article, "The Time of Stars" featured in *Krasnaya Zvezda*, the armed forces daily, on May 1. He stated that his orbiting flight of April 12 "does not end" his career. "I want to do some real flying," he emphasized, and wrote of his hopes for rocket trips to the Moon, Mars, and Venus.

But human journeys that far

are ruled out, for the near future, by Soviet scientists. One week after Gagarin's flight, *Komsomolskaya Pravda* published an interview with Academician Vasily V. Parin, in which that foremost Soviet space-medicine expert maintained that for the time at hand "biologists won't give the cosmonaut their permission" to fly to the Moon. Such longer routes have to be investigated thoroughly "first by automatic instruments, later by animals, and only then a man would fly."

But the door to such exploits is open. Professor Parin says: "The main job is done. Others will follow Gagarin. In time, men will walk in that eternal lunar dust, will fly from planet to planet, will learn to live in Cosmos for as long periods of time as they would wish—will, finally, penetrate to other stars, too."

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Space Has Small Military Value—Now

by Reed Bundy

PRINCETON, N.J.—The nation's space program so far includes nothing of "important military value" other than reconnaissance satellites, Courtland D. Perkins, former Assistant Secretary of the Air Force for Research and Development, said here recently.

"Reconnaissance is a real strategic role—though peripheral—and it has DX-1 priority," Perkins said. "But so far nothing else of important military value has been found in the space program."

The former AF official, now chairman of Princeton University's Department of Engineering, moderated a symposium on "National Perspectives in Space," held by the Princeton Section of the American Rocket Society.

Other speakers at the off-the-cuff session were Dr. E. W. Engstrom, senior executive vice president of Radio Corporation of America; Dr. Donald F. Hornig, head of Princeton's Chemistry Department and a member of the President's Scientific Advisory Committee; Dr. Klaus E. Knorr, economics professor and former consultant to the Rand Corp.; and Dr. Robert Jastrow, chief of the Theoretical Division, National Aeronautics and Space Administration.

Perkins, who served as Chief Scientist of the Air Force in 1956-57 before becoming assistant secretary, said that he thought that "under the circumstances it was a pretty good idea" in 1958 to give NASA responsibility for space and leave the military with strictly military roles.

"It may have delayed space program progress—but it is debatable whether putting it under the military would have gotten it done any quicker."

"In the military," he explained, "we were looking at the space program for things of great military value. We were able to identify very few military applications that couldn't be better served by other means."

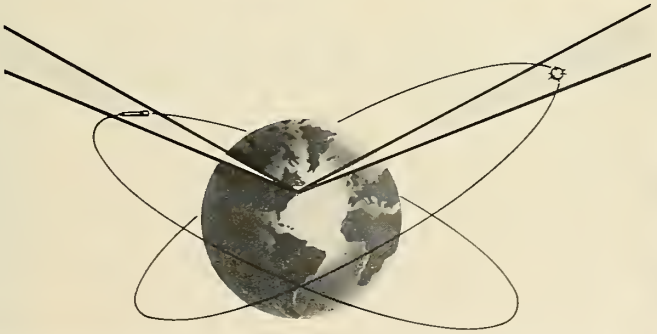
"In my opinion," Perkins said, "nobody has ever been able to show that space-dropping (of bombs from satellites) could be done—or, if it could be, that it could be done as effectively as bombs can be delivered by ICBM's, *Polaris* and *Skybolt*."

As to another suggested military use of space—for platforms from which to launch antimissile-missiles at enemy ICBM's on takeoff—Perkins said "we would love to have a way to do it from space, but nobody has found a way."

• **If opponent knows . . .**—Knorr argued that even reconnaissance satellites would not be of "crucial" military value in spotting war preparations although they might be useful once the conflict was under way.

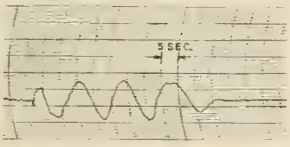
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edge was of overall strategy, rather than space. Knorr discounted the effectiveness of satellites for target intelligence.

"It works well if your opponent does new and different things which can be spotted in satellite photographs," he said. "But if he knows you have such a system, he won't move out of advanced bases before attacking, or do the other things which would be tip-offs. Besides, the Soviets have shifted to mobile systems of missile transport and launching—as we are doing—and the vehicles involved can easily be made to look like peaceful vehicles and equipment."

New knowledge acquired through the space effort in fields such as communications and weather should "upgrade military performance," Knorr said, "but whether this improvement will be any more than marginal is still in doubt. We might find ourselves upgrading performance through space work at the expense of other ways."

Weapon systems in space do not yet "make sense," he said. "We must look at such proposals thoroughly because there may be more in them than we think. But this is R&D only."

• **"Payoffs" lacking**—Perkins said that reconnaissance satellites are the "only military production payoff" in the space field, although various other low-orbit satellites are doing work in such areas as communications and geodesy.

"The *Saint* and *Dyna-Soar* programs will yield hardware contracts eventually, and the military payoff of *Dyna-Soar* is obvious," he said. "Project *Defender* and space bombardment proposals have great potential."

But he observed that "there is no production money for space anywhere in the Fiscal Year 1962 defense budget." He said the Air Force has been given about $1 billion for space work, but it is all R&D money.

• **Industry's obligation**—Dr. Engstrom said there is "some" monetary profit for industry in military and scientific space work, apart from hardware, and that eventually there are profitable applications in the civilian market.

Above and beyond this, he said, industry "has an obligation" to make contributions.

Looking toward the future, the RCA executive said the "demand on existing communication facilities is so heavy and growing so rapidly that, even allowing for the growth of submarine cable, we will need the new space communications facilities by the end of this decade."

He said the questions of who should own, operate and manage the communications satellite system will have to be solved through government-industry cooperation.

• **Space vs. cosmetics**—Dr. Jastrow predicted that operational weather and communications satellite systems will be in orbit within a few years.

"As well as I can tell," Jastrow said, "the economic benefits of the space program will be measured in billions of dollars annually. And our investment in space is only now approaching what American women spend on cosmetics: the ladies invest $2 billion a year on cosmetics, NASA is now inching toward $2 billion a year."

Jastrow said the biggest problem NASA faces in space exploration is the booster gap.

"Everybody has been talking about the gap, but nobody has done anything. We must address ourselves to the question: exactly what *is* our booster requirement?"

Asked whether there were plans to advance the U.S. deadline for a lunar landing, the NASA official said he believed the Administration was "considering acceleration of the *Apollo* program—with more funding."

"More funds would be needed," he said, "but where would they come from? It's hard to get more by raising taxes."

Engstrom said he doubted that the public would be unwilling to sacrifice for the space effort. "I believe that if the people were asked, the space program would get more money than it would know what to do with." ⁂

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(Continued from page 109)

The glider's surfaces must deal with temperatures varying from 2000° to 4000° F on re-entry. A mockup of the glider is to completed by fall.

Boeing says *Dyna-Soar* will have the most exhaustive wind-tunnel program in the history of flight—about three times the total time spent gathering data for the *X-15* and about twice that required for the B-52.

Many combinations of glider and booster must be tested at various speeds —the glider atop the complete missile, the glider and second stage after separation and the glider in free flight. Tunnels used will generate subsonic and transonic speeds, from low speeds to Mach 1.4; supersonic speeds, from Mach 1.5 to 5.5; low hypersonic speeds, from Mach 6 to 10; and high hypersonic speeds, from Mach 12 to 25.

• **Lunar base confusion**—All but lost in the spacecraft debate are considerations for providing vehicles with which to set up a lunar base. Planning in this area is rather nebulous and almost entirely dependent upon progress in big booster development.

Whether a larger version of *Apollo* could undertake this mission is still questionable at this date—particularly if it developed that there was an urgent need for a military base on the moon along about 1967 when the Russians claim they will be there.

Saturn C-2 is generally thought to be the best bet for putting sizable payloads on the moon. But it won't be ready until 1966 or 1967. This is the factor behind military and industry urgings to proceed immediately with a large solid-fueled rocket program aimed at obtaining a booster vehicle by 1965 that could carry out lunar missions.

The Air Force, which has been pushing limited development of big solids, has not made public any designs for spacecraft to go aboard them. Whether it has or will arrive at a ballistic-type shape for manned or unmanned craft is not known.

However, critics of *Apollo* feel that this approach has another major drawback besides its high entry speed:

Apollo, because of its parachute descent system, must land in the ocean. This means that every time it goes on a mission a considerable portion of the U.S. Navy will be tied up in the recovery operation. This would be an expensive and not very convenient expedient, especially if it becomes necessary to build up a rather large and well-populated lunar base involving frequent flights.

An orbital return via a winged craft would seem preferable. ⁂

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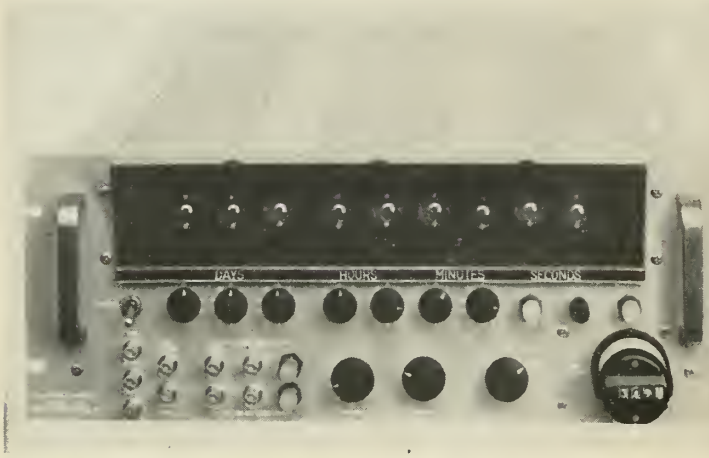
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Fast Warm-Up Tubes

Heater-cathode subminiature tubes with warm-up time of only five seconds are available from Raytheon Co., Industrial Components Division. The QV112 is a medium-mu triode and the QV113 is a sharp-cutoff pentode. Contained in T-3 envelopes, both tubes operate efficiently in the VHF region and operate at bulb temperatures to 220°C.

Circle No. 240 on Subscriber Service Card

High Capacity Readout

A display for annunciators that provides up to sixty messages is available from Industrial Electronic Engineers, Inc.

Called the Series 90000H Display, it is designed for those annunciator applications where simultaneous data is required in a fast, easy-to-read method. It has a capacity of 60 messages which may be displayed individually or in combination, or a 50-message capacity with red or green color backgrounds available.

Circle No. 241 on Subscriber Service Card

Parallel-Wire Tape Punch

A multi-magnet tape punch designed to receive parallel-wire input from message communications equipment has been developed by Teletype Corp. Model 28 LARP is electro-mechanically operated, and provides programed storage in fully perforated tape. Operating at 20 characters per second, the off-line tape punch is available for 5, 6, 7, or 8 level operation, and will remove the problem of tape preparation from system planning.

Circle No. 242 on Subscriber Service Card

Micrologic Circuits

MicroSemiconductor Corp. is marketing silicon micrologic circuits. Basic size for 4, 6, or 8 silicon diode configuration is 0.030 thick x 0.125 wide x 0.250 long. Leads are gold-plated and ideally suited for welding and soldering techniques. Individual diode electrical parameters are available in excess of 2 nano-seconds recovery and 2 picofarads capacitance.

Circle No. 243 on Subscriber Service Card

High Pressure Hose

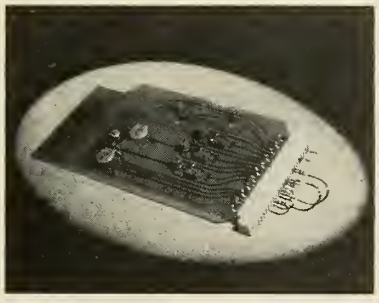
Teflon high-pressure hose in a −16 size (nominal I.D. one inch) is available from Resistoflex Corp.

The Fluoroflex-T R731 hose is rated for a working pressure of 3000 psi for both fluid and ambient temperatures from −65°F to 400°F. The Resistoflex −16 hose carries with this pressure rating qualification testing to 250,000 impulse cycles, at minimum bend radius and with impulse pressure peaks at 4500 psi.

Circle No. 244 on Subscriber Service Card

Logic Module

A 1-megacycle, triple-inverter logic module is available from Harvey-Wells Electronics for gating and strobing pulses and levels as well as for inverting pulses and levels. The three independent inverter stages may be connected in



series, in parallel, or in series-parallel, according to the logical requirements of the application. Inputs to the three inverters can be in the form of pulses or levels. Pulse requirements are 4 volts amplitude and 4 micro-seconds width. The required voltage levels are 0 and −4 volts.

Circle No. 229 on Subscriber Service Card

Hi-Temp Pyrometer

An automatic pyrometer which both measures and controls extremely high temperatures continuously is available from Atomics International, a division of North American Aviation, Inc.

The pyrometer can instantly measure and regulate temperatures to 4000°C while recording changes to less than one degree. With attachments the device is capable of operating in a temperature

ONE SECOND SENSITIVITY

to exactly set and check angles



MICROPTIC PRECISION CLINOMETER

Highly sensitive yet easily handled, the Microptic Precision Clinometer is designed for all calibration and machine setting purposes requiring the highest accuracy.

Angles through 360° are measured by referring the instrument base to the true horizontal — the inclination is read directly from the circle scale through a reading microscope. The eyepiece can be rotated to face in any direction. Interchangeable units permit daylight or artificial illumination of the reading system.

The Precision Clinometer is invaluable in setting inclinable tables for jig borers, and angular work on grinding and lapping machines; for checking angular faces and locations on jigs, fixtures and gages.

...New

Accessories—for use in horizontal position; to measure angular displacement of small parts; to comply with military environmental specifications for field use.

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range of 10,000°C. Simple design features allow for economical production and operation.

Circle No. 230 on Subscriber Service Card

Powder Injection System

Two powder injection holes make it possible to spray 20% more powder than was previously possible with the SG-1 arc plasma spray gun available from Plasmadyne. Development of the dual injection holes enables more precise control of powder velocity in spraying applications. Coatings now can be tailormade to suit coefficients of expansion of various substrates to meet requirements of different chemical or thermal requirements. Two different powders can be fed into the arc.

Circle No. 231 on Subscriber Service Card

Sweep Generators

A series of RF sweep and signal generators capable of providing up to 4 watts of power are available from Telonic Industries, Inc. Six models, designated PD-1 through PD-6 are included in the line of test instruments that cover the RF range from 5 to 1000 mc. A switch arrangement on the instrument enables the user to select from four different modes of operation including swept RF, swept RF with 1000 cps square wave modulation, unmodulated CW and CW with 1000 cps square wave modulation.



Circle No. 232 on Subscriber Service Card

Impedance Bridge

A Model 710A Universal Impedance Bridge for measuring the capacitance and dissipation factor of capacitors, the induction and storage factor of inductors, and the AC-DC resistance of resistors is available from John Fluke Mfg. Co., Inc. The unit has an accuracy of ±(0.1% +1 dial division) and a capacitance of 0 to 1200 microfarads in 7 ranges.



Circle No. 233 on Subscriber Service Card

Commutator

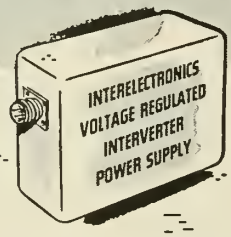
The Electronics Division of Arnoux Corp. is producing a 30-channel unit, designed for airborne general-purpose telemetry. Output levels are maintained within ±0.5% of full scale over entire temperature input-power voltage, duty cycle, and rate ranges with any combination on input signal levels.

Circle No. 234 on Subscriber Service Card

Silicon Rectifier

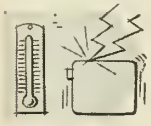
Solitron Devices, Inc. has available a double diffused axial type silicon rectifier with a hermetically sealed insulated body capable of ratings up through 6

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Ultro-relioble in operotion (over 260,000 logged hours), no moving ports, unhormed by shorting output or reversing input polority. Wide input ronge (18 to 32 volts DC), high conversion efficiency (to 92%, including voltoge regulotion by Interelectronics potented reflex high-efficiency mognetic omplifier circuitry).

Light weight (to 6 wotts/oz.), compoct (to 8 wotts/cu. in.), low ripple (to 0.01 mv. p-p), excellent voltoge regulotion (to 0.1%), precise frequency control (to 0.2% with Interelectronics extreme environment mognetostrictive stondords or to 0.0001% with fork or piezoelectric stondords).

Complies with MIL specs. for shock (100G 11 mlsc.), occelerotion (100G 15 min.), vibrotion (100G 5 to 5,000 cps.), temperoture (to 150 degrees C), RF noise (1-26600).

AC single ond polyphose units supply sine woveform output (to 2% hormonics), will deliver up to ten times roted line current into o short circuit or octuote MIL type mognetic circuit breokers or fuses, will stort gyros ond motors with storting current surges up to ten times normol operoting line current.

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Interelectronics—first ond most experienced in the solid-stote power supply field produces its own oll-silicon solid-stote goting elements, oll high flux density mognetic components, high temperoture ultro-relioble film copocitors ond components, has complete focilities ond know how —hos designed and delivered more working KVA thon ony other firm!

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Circle No. 50 on Subscriber Service Card

amps. The hermetically sealed units are available for immediate delivery in a choice of three configurations: (1) axial type with molded, insulated body, (2) axial type with molded, insulated body with lugs on both ends or (3) for direct replacement of the stud base types.

Circle No. 235 on Subscriber Service Card

Circuit Protector

An electronic circuitry protector, a sealed, direct current operated, non-polarized, electromagnetic fault or overload current limiting device with self-resetting capabilities, is available from North Electric Co. Speed of operation of the CP-226 depends upon overload magnitude, within 1 to 10 milliseconds of fault occurrence. It trips within ±10% of specified current.

Circle No. 236 on Subscriber Service Card

Shaft Encoders

A line of 20 and 30 analog/digital, detented shaft encoders is available from Guidance Controls Corp. Known as the DADC Series, this line was developed for those read-out applications where it is necessary to translate a rotary shaft position to a coded digital output (binary) for tape storage or direct insertion into digital computers.

Circle No. 237 on Subscriber Service Card

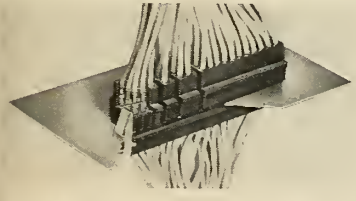
Tunnel Diode Amplifiers

A complete line of low-noise, narrow-band tunnel diode amplifiers, NTA Series, is available from Micro State Electronics Corp. NTA amplifiers are self-contained units which may be added directly to the front end of existing radar, troposcatter, ground and satellite communication systems. The units are available with 0-10% bandwidths over a range of 375-1400 mc.

Circle No. 238 on Subscriber Service Card

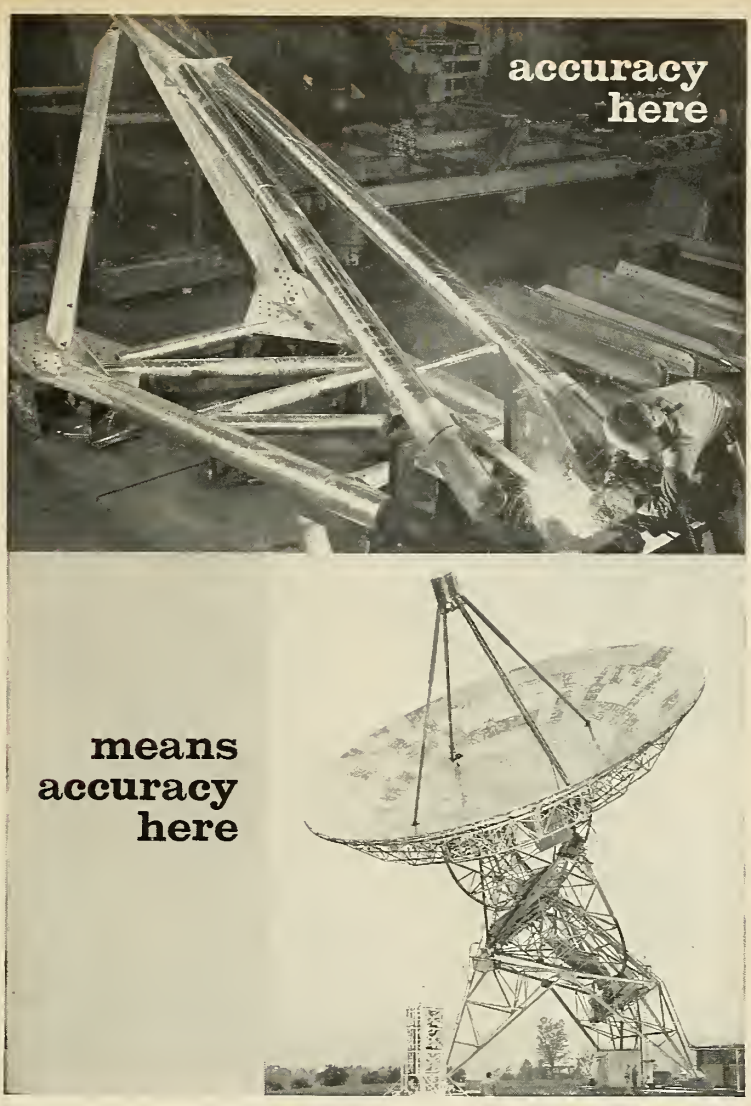
Modular Units

Modular plug and receptacle units capable of multiple circuit connections from 3 to 60 circuits are available from Molex Products Co. Additional polarization is possible by inter-mixing male



and female terminals in plugs and receptacles. The round, pin-type terminals automatically crimped to wires eliminate soldering and permit fast, simple assembly.

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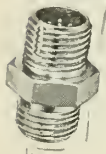
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names in the news

Dr. H. Guyford Stever: Professor of Aeronautics and Astronautics at Massachusetts Institute of Technology, elected to the Board of Directors at Trans-Sonics Inc., Lexington, Mass. Dr. Stever is a member of the Defense Science Board and chairman of the NASA Research Advisory Committee on Missiles and Space Vehicle Aerodynamics. He is also a member of the Scientific Advisory Committee to the Committee on Science and Astronautics of the U.S. House of Representatives.

James W. Dunham: Named president of Space Recovery Systems, Inc., El Segundo, Calif., a division of Itek Corp. Prior to joining SRS, Dunham was research director of Booz-Allen Applied Research, Inc.

Dr. Carl L. Kober: Former vice president of Avco Corp., appointed director of Advanced Programs for The Martin Co.'s Denver Division.

Dr. Paul Kruger: Joins Hazleton-Nuclear Science Corp., as manager of the Nuclear Projects Dept. Formerly Dr. Kruger held similar responsibilities with H-NS' Eastern affiliate, the Nuclear Science and Engineering Corp., Pittsburgh, Pa.

Wells Chapin: Appointed manager of marketing for communications, Avco's Electronics and Ordnance Division, Cincinnati. Before joining Avco, Chapin was associated with the Dage Division of Thompson Ramo Wooldridge, Michigan City, Ind., and General Electric's Electronics Division.

L. J. "Lew" Staehle: Promoted to assistant to the general manager of Lockheed's Missiles and Space Division. With Lockheed since 1954, Staehle will coordinate the activities of all organizations at the Van Nuys, Calif., plant for the division general management.

Dr. Frederick W. Lipps: Former research physicist at Aerolab Development Co., joins Electro-Optical Systems, Inc., as senior scientist in the Fluid Physics Division, Pasadena, Calif.

Lawrence G. Lutz: Named manager of the new West Coast plant of J. W. Fecker Division of the American Optical Co., Santa Monica, Calif. **William O. Hedge** named products manager.

Warren C. Hume: Promoted to president of the Data Processing Division, International Business Machines Corp., succeeding **Gilbert E. Jones,** who has been appointed assistant to the president.

Larry G. Hastings: Former information director for NASA's Goddard Space Flight Center, appointed director of public relations for Washington Technological Associates, Rockville, Md.

L. D. Brown: Named chief engineer for Aerotest Laboratories, Inc., Deer Park, L.I., N.Y., and will continue as chief engineer of the Advanced Propulsion Division.

Maj. Gen. William L. Rogers: Vice-commander of the Missile Test Center, Patrick AFB, Fla., named commander of the Arnold Engineering Development Center, Tullahoma, Tenn. **Colonel Harry J. Sands, Jr.,** has been named to replace Gen. Rogers at the AFMTC.

Richard G. Weber: Appointed regional planning manager and will form and manage the Washington Office of Cutler-Hammer's AIL Division. Before joining AIL, Weber was manager, systems planning, of General Electric Co., Bethesda, Md.

Louis H. Aricson: Vice president of Daystrom, Incorporated, named chief executive Officer of the Weston Instruments Division, Murray Hill, N.J. **Joseph F. Degen:** Former Weston general manager, assigned to the corporate staff post of assistant vice president, manufacturing.

Dr. James L. Wyatt: Named vice president for program development at the Armour Research Foundation of Illinois Institute of Technology.

Charles R. Covey: Appointed manager of manufacturing for Texas Research & Electronic Corp., Dallas. Formerly Covey was manufacturing superintendent, Semiconductor Division of Texas Instruments Incorporated.

H. E. Bauer: Former assistant chief project engineer on the *Skybolt* program at Douglas Aircraft Co., Santa Monica, Calif., named *Skybolt* program manager, succeeding **J. A. Gorgenson,** who has been assigned to the staff of the vice president-defense programs.

Philip S. Hanson: Named product development engineer at The Beryllium Corp., Reading, Pa. Previously Hanson was with Bridgeport Brass Co. and Monsanto Chemical Co.

Dr. John M. Brahant: Former staff member of the National Bureau of Standards, joins operations staff of The Bissett-Berman Corp., Santa Monica, Calif.

Donald W. Baisch: Appointed assistant to the vice president of Telecomputing Corp.'s Electronic Systems and Value Engineered Products Divisions. **John W. Rhyne, Jr.,** named chief electrochemist of TCC's Power Sources Division, Denver.

Dr. Donald C. Schiavone: Authority on design and development of rocket engines, named director of reliability on corporate engineering staff of The Martin Co., Baltimore. Previously, Dr. Schiavone was assistant chief engineer of the Rockets Division, Bell Aerosystems Co., and manager of propulsion system design for the Chrysler Corp.'s Missile Division.

Edgar O. Dixon: Named manager of the systems group at American Optical Co.'s Research Center, Southbridge, Mass., presently completing development of a target-detecting device for the advanced *Sidewinder* missile.

contracts

NASA

$3,250,000 — **Radio Corporation of America,** New York City, from Goddard Space Flight Center, for construction of the *Relay* communications satellite.

$1,276,000—**Alpha Corp.,** Dallas, subsidiary of **Collins Radio Co.,** from Goddard Space Flight Center, for equipment and electronic systems for tracking and receiving data relayed from satellites.

$264,771—**Bendix Corp., Radio Div.,** Owings Mills, Md., from Flight Research Center, Edwards AFB, for operation and maintenance of two tracking stations within the *X-15* high range.

$94,800—**Progressive Welder and Machine Co.,** Pontiac, Mich., from Marshall Space Flight Center, for a fifth *Saturn* assembly fixture.

$75,000—**Martin Co.,** Baltimore, for Earth-Lunar Transport project study of launch vehicle systems for lunar exploration beyond the initial Project *Apollo* flight.

Menasco Manufacturing Co., Burbank, Calif., from **Douglas Aircraft Co.,** for titanium-alloy pressure vessels for *Saturn S-IV.*

ARPA

$81,708—**Space Technology Laboratories,** Los Angeles, from **General Dynamics/Astronautics,** for experimental modules to be attached to *ARENTS* (ARPA Environmental Test Satellite).

ARMY

$2,180,000—**Fairchild Engine & Airplane Corp.,** Hagerstown, Md., additional funding for modification of two AN/USC-5 drone surveillance systems.

$716,954—**Defense Electronic Div. of Radio Corporation of America,** Moorestown, N.J., for installation of instrumentation tracking radar on Pacific Missile Range.

The Garrett Corp.'s AiResearch Manufacturing Division, Phoenix, Ariz., for small gas-turbine engine for the *Mauler* missile. No amount disclosed.

NAVY

$21,000,000—**North American Aviation, Inc.,** Downey, Calif., from BuShips, for Ships Inertial Guidance Systems (SINS) for nine Lafayette-class *Polaris* submarines.

$6,970,000—**Hughes Aircraft Co.,** Culver City, Calif., for combining *Polaris* inertial guidance platforms produced by another firm with Hughes-made guidance electronics systems and testing in the assembled units; $2,400,000 from **General Electric** for circuit boards for digital computers used in *Polaris* guidance units.

$1,001,108—**Texas Instruments, Inc.,** from BuWeps, for AN/APS-88 radar systems.

$700,000—**Sperry Microwave Electronics Co., Div. of Sperry Rand Corp.,** Clearwater, Fla., from BuWeps, for parametric amplifiers.

AIR FORCE

Westinghouse Electric Corp., Pittsburgh, Pa., from Boeing Co., multimillion-dollar contract for generator and control unit for *Dyna-Soar* manned space glider.

Sundstrand Corp., Denver, from Boeing Co., multimillion-dollar contract for an accessory power unit for the *Dyna-Soar.*

Douglas Aircraft Co., Santa Monica, Calif., multimillion-dollar contract for 22 DM-21 *Thor* rockets for use as boosters in space programs.

Thompson Ramo Wooldridge, Seattle, from Boeing Co., multimillion-dollar contract for research and development work on the *Dyna-Soar.* **TRW's Tapco Group,** Cleveland, will provide *Dyna-Soar's* reaction control power component.

Thiokol Chemical Corp., Elkton, Md., from Boeing Co., multimillion-dollar contract for design and development of an acceleration rocket for *Dyna-Soar.*

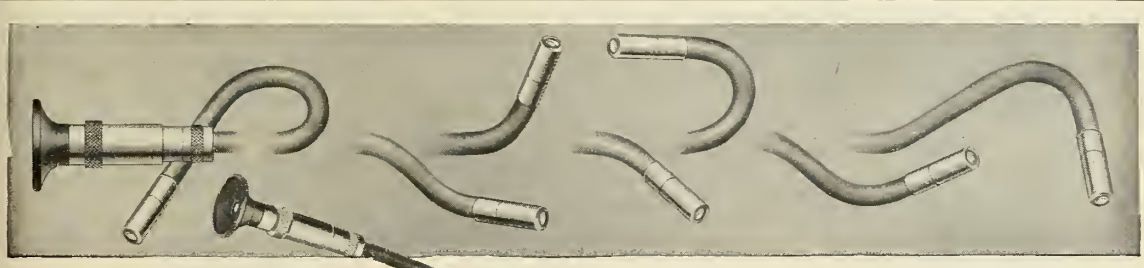
$1,500,000—**Budd Electronics, Div. of The Budd Co.,** L.I., N.Y., for additional TD-285/FST multiplexer units.

$250,000—**The Goodyear Tire & Rubber Co.,** Akron, Ohio, for specially designed tires for the *B-58.*

$100,000—**Daystrom, Incorporated, Pacific Division,** for flight-control stability-reference gyroscopes for the *Hound Dog* missile. From **Autonetics Div. of North American Aviation, Inc.**

$96,474—**Electro-Optical Systems, Inc.,** Pasadena, Calif., from **Aeronautical Systems Div.,** for research and development of metal bolometer-type infrared detectors for use in extremely accurate tracking and reconnaissance devices.

Melpar, Inc., Falls Church, Va., from **North American Aviation,** for high-reliability circuit assemblies and modules for the *Minuteman* ICBM electronic systems. No amount disclosed.



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MAY

7th Annual Radar Symposium, University of Michigan, Institute of Science and Technology, Ann Arbor, May 31-June 2.

JUNE

National Machine Tool Builders' Association, 59th Spring Meeting, Mayflower Hotel, Washington, D.C., June 1.

American Society for Quality Control, Annual Convention, Sheraton Hotel, Philadelphia, June 5-7.

International Instrument Conference and Exhibit, Instrument Society of America, Royal York Hotel, Toronto, Canada, June 5-8.

National Electrical Manufacturers Association, Western Conference, Biltmore Hotel, Los Angeles, June 8-9.

Manufacturing Chemists Association, 89th Annual Meeting, The Greenbrier, White Sulphur Springs, W.Va., June 8-10.

European Federation of Chemical Engineering, Thirtieth Meeting, Frankfort-am-Main, Germany, June 9-17.

American Society of Mechanical Engineers, Statler Hilton Hotel, Los Angeles, June 11-15.

Third National Symposium on Radio Frequency Interference, Institute of Radio Engineers, Sheraton Park Hotel, Washington, D.C., June 12-13.

Instrument Society of America, 3rd International Symposium on Gas Chromatography, Michigan State University, East Lansing, June 13-16.

Joint ARS-IAS Meeting, Ambassador Hotel, Los Angeles, June 13-16.

American Society of Mechanical Engineers, Applied Mechanics Conference, Illinois Institute of Technology, Chicago, June 14-16.

American Rocket Society, Semiannual Meeting, Biltmore Hotel, Los Angeles, June 14-17.

American Society for Testing Materials, Annual Meeting, San Francisco, June 16-21.

IAS Symposium on "Space Flight and Re-entry Trajectories," Paris, June 19-21.

Heat Transfer and Fluid Mechanics Institute Conference, University of Southern California, Los Angeles, June 19-21.

American Association for the Advancement of Science, Pacific Division, Annual Meeting, University of California, Davis Campus, June 19-22.

Carbon Conference, Pennsylvania State University, and American Carbon Committee, University Park, June 19-23.

Denver Research Institute of the University of Denver, Eighth Annual Symposium on Computers and Data Processing, Elkhorn Lodge, Estes Park, Colo., June 22-23.

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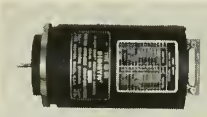
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editorial . . .

Why We Are Going Into Space

SPACE is there. Man will go there.

We present in this issue the arguments against his going as well as those in favor of it. But the outcome is inevitable.

Two men, in fact, already have gone and returned. One was a Russian; the other, American. These first space explorers will be followed by many. many more.

Numerous reasons have been put forward to explain why. These might be grouped into four major theories:

The Hillary Theory. Man will go into space if for no other reason than the fact that, like Mt. Everest, it is there.

The Columbus Theory. Thc true commercial value of the voyage of Columbus became evident only in retrospective. The same will be true of space exploration.

The Archimedes Theory. Advancement of pure science is more important even than life itself. That as Archimedes, intent upon his mathematics, was killed during Marcellus' sack of Syracuse, so men always will risk all to increase basic scientific knowledge.

The Panama Theory. Powerful military and political needs of the leading nations of the world make it imperative for them to hold dominant areas of space which, like the Panama Canal, are important to national survival.

The last of these is at the moment perhaps the most compelling, although in the long run not necessarily the most important. We must extend our national effort into space because the Russians are going and we dare not let them go unchallenged.

Even if there were no Russians, we would accept the challenge of the stars. Sooner or later, we would go. It is, however, the political-military competition between the United States and the Soviet Union which lends urgency to our space programs.

Our drive to catch up with the Russians is a two-pronged effort, by the military and by the National Aeronautics and Space Administration.

A GLANCE is sufficient to indicate that in neither of these areas is the effort and planning strong enough for our national survival. Only recently has a military mission in space even been recognized. More money, more thought must be given to what we intend to accomplish militarily.

Elsewhere in this issue, you will find NASA answers to four important questions about our space effort submitted by MISSILES AND ROCKETS. The answers indicate a lack of planning by the previous Administration and too little effort by the present Administration to remedy it.

Long before now, a study should have been made of scientific objectives we hope to accomplish in space between the three-orbit *Mercury* flight and the first *Apollo* flights. NASA should know more precisely both what the objectives are and what funding is required to attain them. There is a broad gap between the programs as they now stand.

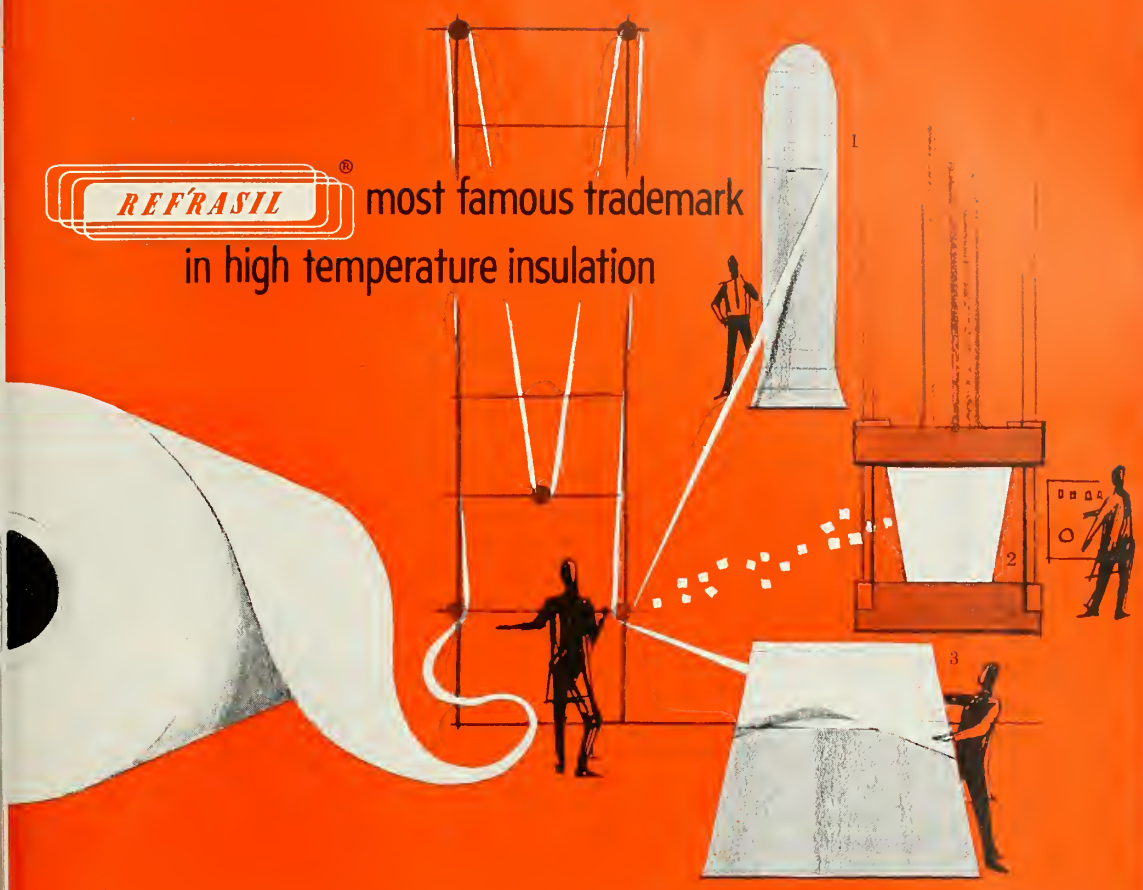
We have also attempted to point out in this issue some of the technical areas in which further research and engineering now is needed if our space effort is to be successful on a time-scale competitive with the Soviet Union. These problem areas must be tackled immediately.

We cannot afford to be second in this race.

William J. Coughlin

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JUNE 5, 1961

missiles and rockets

THE MISSILE/SPACE WEEKLY

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JFK Switch Leaves Door Open for Military M-I-S

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Yes, there *is* something new under the sun. Science is proving this every day. With new discoveries. New explorations. New concepts.

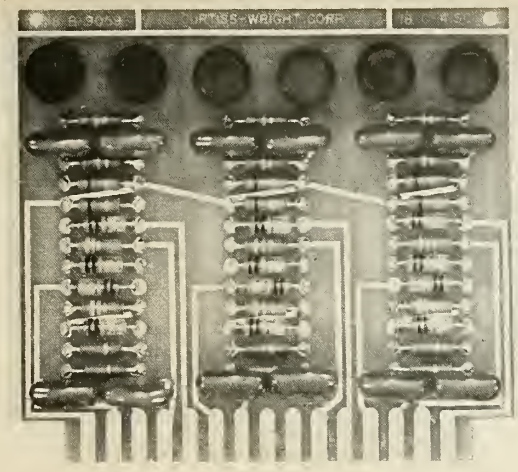
Nowhere is this more evident than in the field of technology. For example: On the drawing boards of Lockheed Scientists and Engineers, new designs are constantly being born—designs in Spacecraft and Aircraft that will reinforce and enlarge our growing knowledge of Outer Space.

These new designs are rapidly developing. And their number is rapidly increasing. The pace is fast. Yet it needs to become faster. To keep pace, Lockheed needs more Scientists, more Engineers. Result? The future for Lockheed was never more promising—the opportunities never greater.

Lockheed feels that trained men will do well to examine thoughtfully the Company's current openings. Notable among these are: Aerodynamics engineers; thermodynamics engineers; dynamics engineers; electronic research engineers; servosystem engineers; electronic systems engineers; physicists (theoretical, infrared, plasma, high energy, solid state, optics); hydrodynamicists; ocean systems scientists; physio-psychological research specialists; electrical-electronic design engineers; stress engineers; and instrumentation engineers.

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What can a skipping stone teach us about re-entry from space?



One promising approach to the problem of atmosphere re-entry is called the skip-glide path. The spaceship would follow an undulating trajectory, glancing off the atmosphere to lose its speed, much as a stone skips across the water. The necessary lift might be provided by a deployable pneumatic wing which would inflate on entering the atmosphere.

This and other approaches to aerospace deceleration are now being studied and evaluated at Northrop's Radioplane Division as part of its comprehensive program in landing and recovery systems. Long recognized as the leader in all aspects of paradynamics, Radioplane is fast becoming the industry's standard for space and aerospace landing systems. Active programs now include lunar soft landing studies, aerospace decelerators, and re-entry drag devices as well as recovery and landing systems for *all manned space vehicles actively scheduled by the U.S.*

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THE MISSILE / SPACE WEEKLY

missiles and rockets

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THE COVER

Atlas ICBM lifts off successfully from coffin-type launcher at Vandenberg AFB May 24. Shot by SAC crew was described by AF as an "operational and testing exercise."

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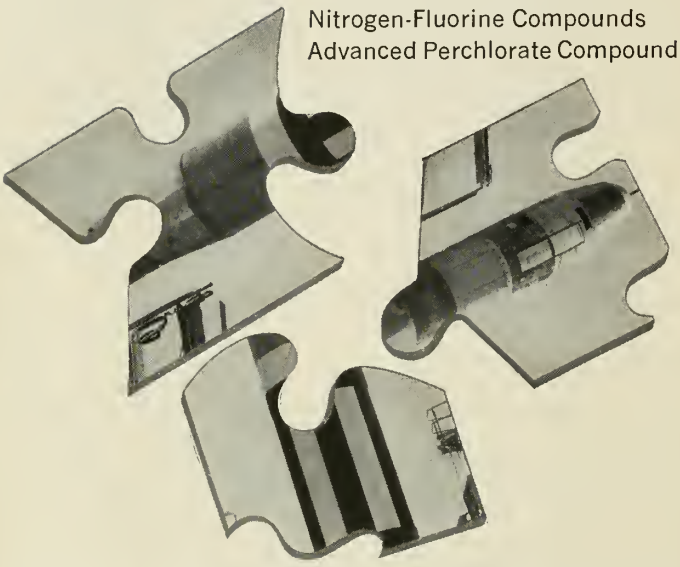
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letters

Pro MR-3 Publicity

To the Editor:

I was rather startled at the reaction to your editorial on publicity prior to the *Mercury* shot. I certainly did not feel that the editorial was "Communistic," but I do not entirely agree with it.

Granted, the glare of publicity was almost overwhelming. There was certainly too much—or at least too much of the wrong type of publicity. Yet, it has proven most useful that we *did* have publicity.

Looking at our publicity effort, it strikes me that in some respects this is exactly the type of way it would have been handled were the United States the only country with a space effort. In such a case, failure or success would be equally "impressive" to an attentive world; had we no competitors, the very fact of our doing the experimentation would be enough. A failure, in such a case, would still be a demonstration of imaginative experimentation.

Such, however, is not the case. We are competing for space with another power, a power both vigorous and aggressive. And in many aspects we are behind in our race.

Each side has several advantages. In the case of the Soviet, their triumphs can be publicized and their defeats buried. This certainly presents a picture of a fairly foolproof technology, which is exactly the picture they wish to present.

In the case of the United States, our failures are brought out into the light, showing that we do not have a perfect technology. This is bad. On the other hand, the successes are felt all the more because the listening world can share in the experience. And this is why the world was at least (if not more) thrilled with the suborbital shot of CDR Shepard than with the orbital flight of Major Gagarin.

Now let's examine what would happen if we clamped as rigid a censorship on our shots as the USSR does on theirs. At the present, the USSR has more massive vehicles than the U.S. has. If we tried to compete for them on this basis, we would, in my opinion, lose much ground. All the Soviets would have to do would be to launch a really massive missile. All our efforts and announcements would look like a pure case of "me-too" to the rest of the world.

Let's face it; our advance publicity—harmful as it can be—is our greatest counteroffensive weapon to the Soviet shots. Not only does it give the rest of the world a *rapport*—a feeling of sharing in the venture, but in addition it demonstrates graphically the meaning of a free press.

This goes deeper than mere "sour grapes"-ing. It is immaterial whether the USSR had 20% or 100% successes in their shots. What is important is that people can see what happens while it is going on, not after it is an accomplished fact.

This leads us to a problem: how does one handle the publicity properly? The *Vanguard* publicity demonstrated crushingly that there is certainly a wrong way to go about it, even if it does pay off as in

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he case of CDR Shepard's shot. The Soviet method has its faults, too, in that it does not allow identification with the project.

I fully believe that the answer is to re-channel our publicity. Certainly, the public should be allowed to share in the launching of a bird, but even more important, the world should be made aware of the incredible complexity of a rocket as an integral part of the publicity. There should be a cold appraisal of the chances for failure, and not mentioned in an offhand manner. There should be, in addition, a demonstration of what data can be obtained even from a failure. Naturally, this information can be classified, but certainly it can be demonstrated what *sort* of data can be used.

As for "failure journalism," this can be classified two ways, too. There is both constructive and destructive journalism in this respect, too. If my somewhat creaky memory does not play me false, Milton Rosen, in his book *The Viking Rocket Story*—the first edition, at least—mentions both kinds when experimentation was starting on that vehicle.

Granted, the Public likes to see an expensive fireworks display. They like to Swell With Pride upon attainment of the objective. But if a little more detail of how much information can be obtained on a partial success—a "failure" to the Public, it would help a great deal to place missile operations in the proper light. That goes not only for our country, but for the world.

Let's keep our publicity—it would be a crime to throw it away. But let us learn what publicity is appropriate, and develop the correct way of presenting it. That's the easiest way to win this game. Perhaps the only way . . .

Stephen A. Kallis, Jr.
Buffalo, N.Y.

Moon's Potential

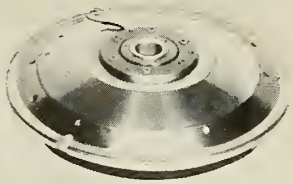
To the Editor:

I am somewhat concerned about the apparent lack of national interest regarding the Moon. Our policy seems to be, "What's the hurry; it's just a big rock in vacuum." I strongly suspect that this is as far short of the truth as one can get.

For one thing, the geophysics of a body is likely to be strongly modified by its mass and density. Probably the cooling of the Moon followed a drastically different course than that of the Earth. One assumption which could be made is that the Moon developed a crust much earlier than Earth, and then continued to cool until it was sensibly totally solid. This should have led to the formation of numerous shrinkage voids.

During the period between crust formation and final interior solidification, a structure consisting of concentric thermo-shells may have developed. These in turn may have involved the formation of layers of shrinkage voids till a depth was reached where pressure would no longer allow such formations to exist. As each cell formed and shrank, a new cycle of volcanic activity could be expected to occur. The resulting lava flows would often force through to the surface and repeatedly form

(Continued on page 46)

KEARFOTT SYNCHROS AND RESOLVERS FOR GIMBAL APPLICATIONS

Precision wound components for direct mounting to gimbal structures are now available for application in gyros, platforms and other devices. These components can be supplied with or without appropriate precision bearings.

A wide range of mounting configurations are available and special adaptations can be provided. High accuracy components, featuring maximum error of 20 seconds of arc are in quantity production. Improved accuracy can be provided as required. Materials used as housing can be either aluminum or beryllium weight reduction. Stainless steel housings for rigidity and corrosion resistance are available in many standard units.

Typical gimbal mounted components are tabulated below. Special units are available with beryllium housings and include two multipole (equivalent to 25 speed) units with accuracy of 12 secs/speed. The CZ 06311 001 is a synchro transmitter, the CZ 09623 001 is a combination transmitter-DC torquer concentrically mounted. A "piggy-back," two unit transmitter, one 3 wire the other 4 wire with stack height of 1" is also available.

SPECIFICATIONS

Typical Part Numbers	Size	Function	Excitation	Accuracy
325720 325721	8	Resolver	2V 400 cps	15 min.
(Diameter .750". Length 1.250" See 3Z6390-001 below)				
3Z6390-001	25	Resolver Transmitter	20V 900 cps	3 min.
("Ring" housing—special hub designed to operate concentrically around a smaller unit.)				
CZ06360-002	As req'd.	Resolver Transmitter	115V 800 cps	20 sec.
(Pancake configuration beryllium housing 5.375" dia. X 1.437" high.)				
.5Z6360-009	As req'd.	Resolver	115V 800 cps	3 min. or 5 min.
(Flat aluminum housing conforms to BuOrd 1980052-MIL-R-21530.)				
209981 209984	23	Resolver	As required	10 min.
(High accuracy machined stack allows direct mounting without housing.)				
3Z6210-006	25	Synchro	As required	2 min.
(Various hub and housing configurations available.)				
1/3Z6360-006	As req'd.	Resolver	115V 800 cps	20 sec.
(High accuracy transformation ratio 1.0160 conforms to BuOrd 1980055.)				

Write for complete data

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In early 1960, American craft pierced the North Pole in two elements. Fathoms below solid ice, the USS Sargo probed unerringly to "90 North"; miles above, a GAM-77 missile on a B-52 pinpointed the featureless goal. Both used Inertial Navigation systems by Autonetics—where today's results pave the way for tomorrow's breakthroughs.

Electromechanical Systems by **Autonetics** Division of North American Aviation

The Countdown

WASHINGTON

Polaris Moves to the Med

Whether or not NATO accepts President Kennedy's offer of five *Polaris* submarines, the second squadron of U.S. missile-launching submarines probably will operate in and out of the Mediterranean Sea. The second *Polaris* tender, the Hunley, is expected to seek a southern European anchorage either in the Mediterranean or possibly somewhere on the coast of Portugal.

Mobile Minuteman: Four Cars Coming

Despite the shut-off of new money for the mobile *Minuteman* in FY '62, four *Minuteman* train cars will be completed for tests with earlier funding. The ACF-AMF cars include: Two launch cars, one power car and one command car. The first launch car already has been completed and delivered to Boeing.

Mercury Present: A Fiscal Demise Soon

NASA is planning to end the *Mercury* program as such after it accomplishes the first manned orbital flight at a total cost of about $408 million. From then on, all *Mercury* capsule shots will be conducted as part of the *Apollo* program.

Mercury Future: Men and Monkeys

The expected post-orbit program: Astronauts launched into orbit for as many as 18 times around the earth. Monkeys launched into orbit in modified capsules for as long as a week. Other passengers may include mice.

Special Barge To Deploy ASW Test Net

The Navy is reported to be converting an ammunition barge for laying on the Atlantic floor new Artemis test receivers for long-range detection of submarines. The high-gain receivers are attached to marine cable laid from the barge, which is being outfitted with special handling equipment and receiving elements designed by Pneumo-Dynamics Corp.

INDUSTRY

NASA—Growing Market

Expanded base of space operations being laid down by President Kennedy will have a Topsy-like effect upon NASA. Continued acceleration of the man-in-space program in the race for the moon—along with allied projects—should easily push NASA's budget past the $2 billion mark in FY '63. (The latest Kennedy revision puts the FY '62 figure at $1.8 billion.) Spending by the agency could reach a $3-$4 billion level in the mid-60's. A year ago this figure was considered rather optimistic.

Sea Launch: Industry View

Despite the indifference of NASA and the Air Force, rocket industry executives feel the country eventually will come around to using sea launch techniques for big boosters—both liquid and solid. Sea launch, they point out, could be a way of expediting the space program by bypassing the need for special handling and launch equipment. Some people think the only Air Force objection is that the Navy would be in on the scheme.

R&D Intelligence

Unconfirmed reports have NASA using a $5-million increase in tracking station construction money to build a 200-ft. antenna near the Washington, D.C., area—although it's not known yet whether a dish of this size is feasible. . . . Boeing (which has just let $40 million in *Dyna-Soar* subcontracts) is modifying a B-52 for subsonic air drops of the *Dyna-Soar* glider. . . . COUNTDOWN hears NASA is eyeing the possible development of a 15-million-lb.-thrust single-chamber liquid rocket engine.

Silence at Vandenberg

There's still no Air Force explanation of the explosion which demolished the *Titan I* Operational Silo Test Facility at Vandenberg AFB last Dec. 3. Whether the accident was caused by a sudden failure of the missile-bearing elevator or for some other reason has never been cleared up, even though the Air Force is apparently abandoning this facility.

Titan II Underrated?

Officially, thrust of the 150-ton *Titan II* is pegged at 430,000 lbs. for the first stage and 100,000 lbs. for the second. But COUNTDOWN hears the figures could be, respectively, 500,000 lbs. and 120,000 lbs. Second stage is reported to be 10 months ahead of schedule.

INTERNATIONAL

French FBM in '69?

A nuclear-powered submarine program will reach the building stage during 1963 in France. The three subs in the program, however, aren't expected to be ready for testing until 1967 or to become operational with a *Polaris*-type missile until 1969.

Calling South America

NASA is angling with Brazil and other Latin America nations to join in a communications satellite program. The apparent aim: to improve Latin American relations.

Overseas Pipeline

France may follow West Germany as the second European NATO nation to buy Martin *Pershing* tactical missiles. . . . Martin's George Bunker, incidentally, says his company is prepared to establish production agreements with European companies, but has no desire now to either establish its own facilities there or buy into European firms. . . . Hughes Aircraft has an agreement with France's Thomson Houston to launch a smaller version of the Hughes communications satellite aboard a *Scout* vehicle. . . . France's SEPR propulsion firm confirms it is making a sales/technical information deal with Thiokol Chemical Corp. on solid motors.

K Eyes Mercury Equipment

On his tour of the British Trade Fair in Moscow, Premier Khrushchev indicated Russia may have some use for the U.S. *Mercury* program. The Kremlin boss noted a display of SARAH (search, rescue and homing) equipment made by Ultra Electronics and employed in *Mercury*, and allowed that Russia "may well" have requirements for it.



Since the early days of "wireless" Blaw-Knox has been designing, fabricating and erecting towers and special structures to support equipment used to penetrate space. This long experience with the problems involved in this field is the reason systems companies and governmental agencies continue to utilize Blaw-Knox specialized facilities.

Call Blaw-Knox early in the planning stages for consultation and assistance on the design and fabrication of either prototype or production items. Blaw-Knox Company, Pittsburgh 38, Pennsylvania.

SPECIAL STRUCTURES AND TOWERS FOR TRACKING, PROBING, SEARCHING, COMMUNICATION EQUIPMENT

BLAW-KNOX

BLAW-KNOX
Special Structures

The Missile/Space Week

Labor Front Brightens

Outlook in the missile and space base construction picture picked up somewhat last week with two actions:

Labor and management pledged a no-strike, no lock-out compact to the Administration.

The Administration set up an 11-man Missile Sites Labor Commission to handle disputes and direct labor-management negotiations when needed.

First evidence of the new system came with the settlement of a month-long dispute at Cape Canaveral between Radio Corp. of America and two photographers' unions.

Shots of the Week:

One of *Nike-Zeus*' big radars tracked an *Atlas* target over the Atlantic Missile Range for the first time May 27.

The test was a prelude to actual *Nike-Zeus* firings at *Atlases* launched from Vandenberg AFB, scheduled for January, 1962. In last week's shot, a radar at Ascension Island tracked an *Atlas* fired 4500 miles away from Cape Canaveral.

The Air Force announced the successful launching of an *Atlas* from Vandenberg AFB May 24. The bird (see cover) was raised from a horizontal emplacement and fired in an operational and testing exercise.

An advanced model Navy *Polaris* had its first failure in three firings from the USS Observation Island May 25. It was destroyed seconds after launch when it veered out of control.

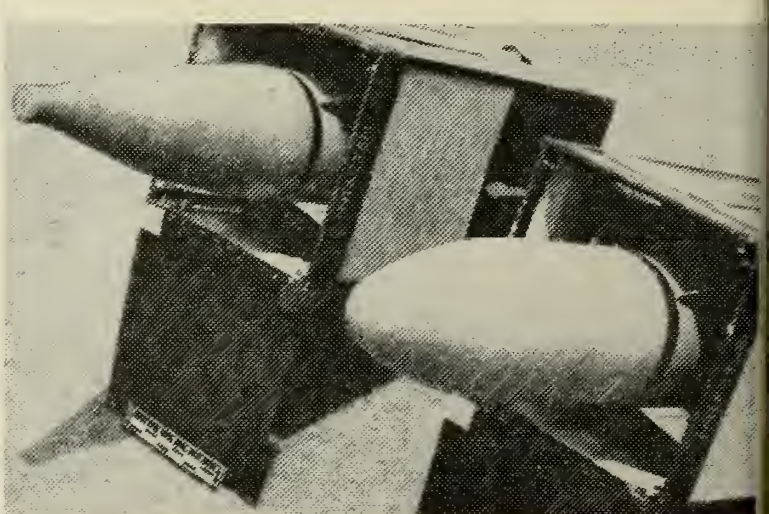
X-15 Scores Again

NASA pilot Joe Walker pushed the *X-15* to a new speed mark of 3307 mph at an altitude of 82,890 ft. The XLR-99 engine ran for 73 seconds, boosting the *X-15* to 107,500 ft. total altitude and raising the lower forward fuselage to 680°F. Walker experienced 50 seconds of weightlessness.

Symington Scores 'Sneaks'

Anonymous "sneaks in uniform" who covertly make disloyal attacks on the Administration's defense policies were attacked by Sen. Stuart Symington (D-Mo.), long schooled in Pentagon politics.

Symington said certain top military officials work anonymously through "favorite press outlets" to attack their civilian superiors. He



First Photo of Nord's Entac Weapon

TWO WARHEADS for the Entac antitank missile which the Army is buying to replac the SS-10 (M/R, March 17, 1961, p. 14). Nord Aviation is the prime contractor.

challenged officers who want to criticize to "resign and do so openly."

New Lineup at Gen. Dynamics

Heads of four operating divisions of the former Convair division have been named presidents of the new General Dynamics divisions:

J. R. Dempsey, former Convair Astronautics chief, to president G-D/Astronautics. He has directed the company's *Atlas* program since 1954.

Charles F. Horne, formerly Convair/Pomona, to G-D/Pomona. Frank W. Davis, Convair/Fort Worth president, to G-D/Fort Worth. Robert C. Loomis, Convair/San Diego, to G-D/Convair, the only division to retain the Convair name.

Army Maps ORO Replacement

Top Army and research organization personnel will meet in New York this Wednesday, June 7, to set up a defense research group to replace the Operations Research Office.

Relations between the Army and ORO, part of Johns Hopkins University, were severed after long-standing disputes over control of research.

Gen. Omar Bradley and a number of executives of Bell Telephone Labs and Massachusetts Institute of Technology are rumored to be in on the planning of a new organization. Most observers see the new group as a counterpart of The Rand Corp., non-profit private corporation which handles research for the Air Force.

Many of ORO's senior scientists apparently have been invited to join the new corporation, although Dr. Ellis A. Johnson, ORO's director, has not.

Dr. Johnson has been quoted as attributing part of the difficulty to the fact that "the Army has wanted to run the research—and that we couldn't tolerate." He also charged that a "conservative group now in control of the Army" wanted to avoid any controversial research.

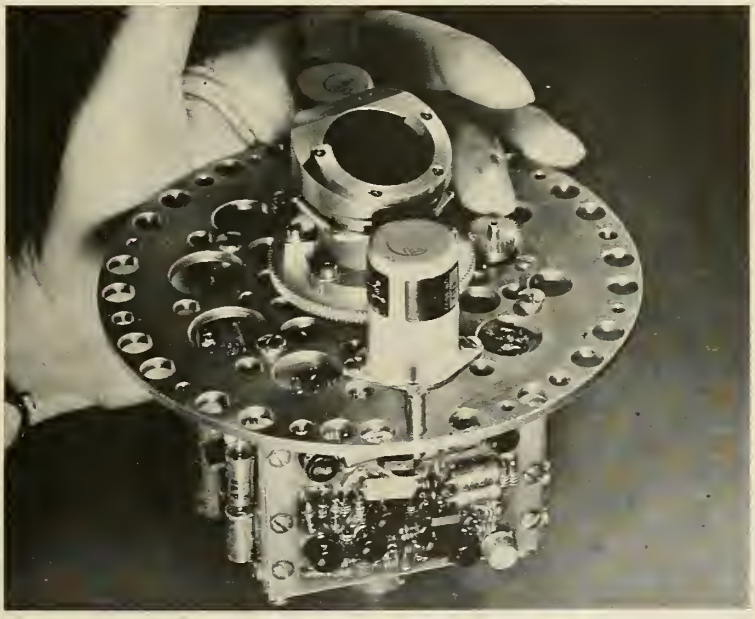
Johnson was critical of secrecy on research findings which he said existed between services.

Sources at ORO said that the Army had been displeased with what it considered leaks of classified information by members of the research organization.

Bristol choppers help first U.S. Astronaut maneuver space capsule

Four Bristol Syncroverter* choppers formed a vital part of the infrared horizon sensors manufactured by Barnes Engineering Company, Stamford, Conn., and carried aloft in NASA's MERCURY capsule by the first U.S. astronaut to reach outer space.

The Bristol choppers function as sensitive phase detectors in the sensors as they establish a horizontal reference plane for the vehicle.



Infrared Horizon Sensor undergoes rigorous optical, mechanical, and electrical checks at Barnes Engineering Co. One Bristol chopper is located in foreground, in front of gear.

Bristol Syncroverter* choppers, noted for low noise, long life and high reliability, are finding a vital place in more and more missile guidance systems, as well as in analog computers, d-c amplifiers, and test equipment for industrial applications. More than 200 models available. Write for complete details.

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New Budget Revision Could Lea

Major shift seen in move by Kennedy to press U.S. space program forward for defense potential as well as gains in non-military technology

by James Baar

THE Kennedy Administration is apparently leaving a wide door open for the development of a manned military space force under the newly-revised space budget.

This amounts to a major policy shift that could prove to be far more significant than President Kennedy's announced decision to pit the United States openly against Russia in a race to put men on the moon.

The Eisenhower Administration repeatedly insisted that there was little future for manned spacecraft of any kind, let alone military spacecraft. The Kennedy Administration, confronted with continuing Soviet space triumphs and mounting evidence that the Russians are developing a military space capability, has clearly reversed the Eisenhower position at least as far as scientific space exploration is concerned.

Moreover, key parts of the $679 million in additional space funds which Kennedy requested Congress to authorize in his personal message May 25 open the way for possible development of a military space force.

The key parts are:

—A solid-propellant *Nova* superbooster, for which $62 million was requested for the Defense Department. This reversed the ban on development of big boosters by DOD.

—The liquid-propellant *Nova*, for which $76 million more was requested for NASA. This is for acceleration of the long-under-funded F-1 engine, designed to develop 1.5 million pounds of thrust and for beginning the design of a vehicle envelope.

—*Titan II*, for which $15 million was requested for the Air Force to convert it for space work, and the *Rover* nuclear-powered rocket program, for which another $23 million was requested for NASA.

—*Apollo*, for which $130.5 million more was requested for NASA to greatly accelerate earlier plans for development of a three-man orbital and lunar spacecraft.

The long-delayed *Nova* superboosters are considered essential for many major military space systems as well as scientific programs such as lunar exploration. Both space-oriented *Titan II* and *Rover* are considered to have dual scientific-military capability. And much technical information from the *Apollo* program and related projects will be useful in designing military systems.

The Kennedy requests carried no additional funds for such Air Force study projects as *ASP*—the aerospace plane—and *Slomar*, a space logistics system. Although funding for such starved projects was sought by Air Force officials, the proposals apparently were shelved by the Defense Department.

• **Insurance policy**—The Administration decision—at least for the present—appears to be to advance a number of important areas of U.S. space technology at an urgent rate so that the information will be available if needed later for military systems. Meantime, as much of the work as possible will be done by NASA to advance U.S. scientific prestige and to avoid the charge of trying to exploit space militarily.

Implicit in this approach is the tendency of the Kennedy Administration to take out insurance policies while deciding what it wants to do—a tendency clearly demonstrated in the Kennedy defense budget for FY '62.

Kennedy and Defense Secretary Robert McNamara apparently have neither accepted nor rejected the repeated warnings from Air Force officials and a number of top civilian experts





o Military Man-in-Space

hat the United States must develop a military manned space force to combat a growing Soviet military space threat. Therefore, while delaying a decision on such programs, the Administration is buying dual capabilities that can be used by NASA.

The President, in his message to Congress May 25, avoided any mention of military space programs at all. His official statement did not even mention that $77 million of the increase was for the Defense Department.

Only once did he even hint at the element of national security involved in the space program. He said it was time for "this nation to take a clearly leading role in space achievement" which may "hold the key to our future on earth."

Dr. Hugh Dryden, NASA deputy administrator, made the point far more bluntly three days later on the NBC program "Meet the Press." He said:

"In order to send a man to the moon it will be necessary to finance and stimulate advances in science which perhaps are not of the exact nature that might have been done without such an integrating force or such a goal. . . . If you like it is insurance against winding up the end of this decade with a science and technology inferior to that of another nation which has pushed forward along the frontiers.

"It is also . . . insurance against military use being made of the new technology and we would be in a very bad way if we had not laid the basis for this technology."

Precisely what NASA and the Defense Department planned to do with the new space funds was not immediately clear in all areas.

• **Boom for NASA**—The NASA part of the accelerated program is based on proposals put together by a 27-man task group representing various NASA centers. The DOD part of the program is understood to be the proposal submitted by McNamara. The program—Kennedy's second revision of the Eisenhower space budget—was put together under the impetus of Soviet Cosmonaut Gagarin's historic orbiting of the earth April 12.

If the program is passed by Congress—and passage is generally expected—NASA will begin a major expansion.

Plans call for hiring 3300 scientists, technicians and other employees. That will increase the NASA payroll from the 18,122 total proposed under the first budget revision last March.

The biggest personnel increase—1000 employees—is planned for the Marshall Space Flight Center at Huntsville, Ala. The March revision set the Marshall payroll at 5960.

The second biggest increase—800—is planned for the Space Task Group at Langley Research Center, Langley AFB, Va. The addition nearly doubles the number set in the March revision.

The Space Task Group, which is directed by Robert R. Gilruth, will manage the *Apollo* program as it has managed Project *Mercury*. Present plans call for establishing the organization in a $60-million manned space flight laboratory that is included in the newly revised budget.

• **Food for Apollo**—The heart of the proposed NASA increase is $376 million for R&D programs. Of this $130.5 million is tagged directly for *Apollo*, but much of the remainder plus much of the additional $173 million for personnel and construction contribute directly or indirectly to the *Apollo* program.

The $130.5 million for *Apollo* would bring to $160 million the total in the budget request for the program. The Eisenhower Administration originally requested only $29.5 million. Nothing additional was sought in the first Kennedy revise in March.

The new FY '62 *Apollo* program will include the letting of R&D hardware contracts on the spacecraft and work on the internal propulsion system that will enable the spacecraft to land on the moon and take off for the return trip to earth. At least three stages of propulsion are expected to be required for this. The lunar-landing *Apollo* may weigh as much as 75 tons.

• **And for Nova**—Along with

NASA May Need Months to Plan Added Apollo Spending

NASA is still in the throes of planning how it can spend the $160 million being earmarked for the *Apollo* three-man spacecraft in FY '62.

Several months probably will elapse before the agency is ready—or able—to move into contracting on a large scale, assuming Congress goes along with the request by President Kennedy.

However, the agency is indicating several new areas in the lunar program entailing a major effort beyond the capsule design, which is still in the feasibility study stage. These include:

• Two-stage capsule propulsion for lunar landing and take-off, which could be vertical or horizontal (see artist's conceptions at left.)

• Greatly increased study of radiation—particularly as it affects living tissue.

• Development of equipment to continually monitor spacecraft position and velocity for integration with pilot-operated midcourse and terminal guidance.

• Checkout and launch control equipment to permit three men to make a successful take-off from the moon.

• Development of composites or systems of materials to insulate the capsule against re-entry heat encountered at 25,000 mph.

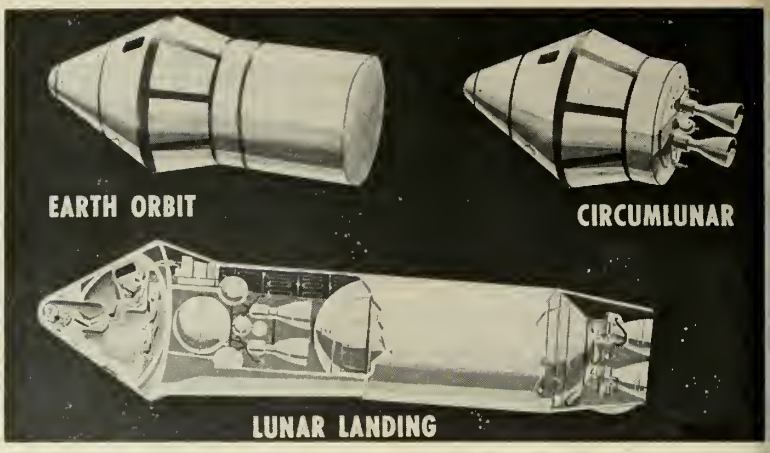
• Determining whether the spacecraft will require artificial gravity.

• Providing sensing and escape mechanisms to protect the crew against a booster failure; also acoustic protection.

The manned vehicle program would be accompanied by a greatly expanded instrumented program (*Ranger, Surveyor* and *Prospector*) to obtain data on lunar surface conditions for design of landing gear. Instrumented craft also will emplace beacons on the moon to be used as landing aids for *Apollo*.



CENTAUR (on Atlas) may also go on Titan II, to increase booster capability.



NASA CONCEPTS for Apollo show modular approach, including in-board propulsion for lunar landing and take-off. Latter concept is here depicted for first time.

Apollo, one of the biggest increases in the new requests is for the liquid-propellant *Nova*. The earlier budget request already contained $42.3 million for R&D work on the F-1 Rocketdyne engine. The new request includes $48.5 million to begin work on the liquid-propellant *Nova* vehicle; $15 million more to accelerate the F-1; and $28 million for *Nova* launching and development facilities—a total addition of $91.5 million.

In all, the budget request now carries $133.8 million for *Nova*. Another $64.2 million has been authorized for the *Nova* program since FY '60.

• **Bones for Rover**—Besides *Nova*, the new requests also carry for propulsion an extra $30 million for development facilities in general and $23 million more for *Rover*. Most of the *Rover* money—$15 million—is for the construction of engine test facilities. The remainder brings to $36 million the *Rover* R&D money requested.

However, despite the added emphasis on *Rover*, NASA has made clear it believes that winning the race to the moon will depend on the development of liquid or solid super-boosters. NASA officials feel that the nuclear-powered rocket will not be available soon enough.

The second Kennedy space revision carried extra funds for three major areas other than manned space flight. One—scientific unmanned space exploration—received $66 million. The second—communication satellites—received $50 million more, bringing the total in the budget to $94.6 million.

The third—weather satellites—received $75 million: $53 million would go to the Weather Bureau; the remainder would go to NASA, bringing the total in the NASA budget for weather satellites to $50.2 million.

No additional money was requested for the *Saturn* 1.5-million-lb.-thrust clustered booster which already had $224.1 million in the first NASA budget revision for R&D—a $56 million increase over the Eisenhower budget.

The first revision also includes for *Saturn* $4 million to shave one year off construction of a second static test stand at Huntsville; nearly $25 million for construction of *Saturn* launch stands at Cape Canaveral; and $600,000 for a second barge to transport *Saturns* from Huntsville to the Cape.

The new Kennedy space budget makes the development of a solid *Nova* booster a companion project to the liquid *Nova*. It is expected to be assigned to the Air Force, although a week after Kennedy's message was delivered no orders from the Defense Department to proceed had been issued.

• **AF boosters**—At present, the Air Force has under way a number of solid super-booster studies under its Project 3059 Office. These could be rapidly expanded with the $62 million requested by Kennedy.

Estimates of how long it would take

(Continued on page 44)

NASA FY '62 R&D

	Eisenhower Budget (January)	First Kennedy Revise (March)	Second Kennedy Revise (May)
Support of NASA plant	$ 74,310,000	$ 77,110,000	$ 89,110,000
Research grants and contracts	7,600,000	7,600,000	7,600,000
Life sciences	8,620,000	8,620,000	20,620,000
Sounding rockets	7,000,000	7,000,000	9,000,000
Scientific satellites	64,700,000	64,700,000	72,700,000
Lunar and planetary exploration	103,899,000	103,899,000	159,899,000
Meteorological satellites	28,200,000	28,200,000	50,200,000
Communication satellites	34,600,000	44,600,000	94,600,000
Mercury	74,245,000	74,245,000	74,245,000
Apollo	29,500,000	29,500,000	160,000,000
Launch vehicle technology	15,000,000	15,000,000	27,000,000
Launch operations development	9,500,000	1,500,000	1,500,000
Spacecraft technology	10,360,000	10,360,000	10,360,000
Solid propulsion	3,100,000	3,100,000	3,100,000
Liquid propulsion	68,700,000	78,020,000	93,020,000
Electric propulsion	6,800,000	6,800,000	6,800,000
Nuclear systems technology	24,000,000	28,000,000	36,000,000
Space power technology	5,500,000	5,500,000	5,500,000
Scout	3,675,000	3,675,000	3,675,000
Delta	2,900,000	2,900,000	2,900,000
Centaur	30,800,000	56,400,000	56,400,000
Saturn	168,160,000	224,160,000	224,160,000
Tracking and data acquisition	38,650,000	38,650,000	38,650,000
Nova	—	—	48,500,000
Total appropriation requests	$ 819,819,000	$ 919,539,000	$1,295,539,000

French, British Bid for NATO Sales

State Department edict against showing offensive weapons shackles U.S. makers—first showings of French AS-30, U.K.'s Red Top

THIS SPECIAL REPORT on the Paris Air Show, which closed yesterday, was compiled on-the-scene by a MISSILES AND ROCKETS *editorial team including Editor William J. Coughlin, Technical Editor John F. Judge, European Editor Anthony Vandyk and Paris Correspondent Jean-Marie Riche. M/R photographs by Bernard Lemoine.*

PARIS—Despite the largest participation to date by individual American firms, the U.S. missile industry was overshadowed at the 1961 Paris Air Show by its British and French competitors.

Foreign firms took full advantage of the XXIV Salon International de l'Aéronautique, held at Le Bourget from May 26 to June 4, to actively push their missile products. U.S. companies, meanwhile, operated under a State Department edict prohibiting display of any offensive missiles. The same prohibition applied to any scale model larger than half size.

With President Kennedy arriving in Europe in mid-week for talks with General de Gaulle in Paris and Premier Khrushchev in Vienna, the intent was to emphasize the "peaceful" aspects of U.S. missile/space efforts.

• **U.S. upstaged**—But U.S. manufacturers trying to sell such tactical weapons as the Sperry *Sergeant,* Martin *Pershing,* Lockheed *Polaris* and Martin *Bullpup* to NATO countries were left at a distinct disadvantage in this premier showplace.

British Aircraft Corp. displayed its truck-mounted English Electric *Blue Water* missile for the first time at the show. (M/R, May 22, p. 12.) In contrast, the competitive Sperry *Sergeant* was represented only by a three-ft. model tucked away in a corner of the large exhibit hall.

While Nord Aviation unveiled its new *AS-30* air-to-surface weapon (see p. 18), there was no sign of the Martin *Bullpup* with which it is competing for NATO contracts. *Pershing* was on hand only as a half-scale mockup, *Polaris* as an even smaller display.

U.S. exhibitors putting finishing touches to their limited displays watched unhappily as a large number of French missiles were set up in the missile park outside the main pavilion and an entire British guided weapons battery rolled in with an operational *Thunderbird* unit.

The battery of the 36th Guided Weapon Regiment of the Royal Artillery then ran through a simulated tactical operation several times each day during the show.

• **Soviet sulk** — Fourteen nations took part in the show with more than 300 exhibits, including those of more than 15 major U.S. manufacturers. Foreign exhibits emphasized tactical missiles, sounding rockets, target drones and rocket engines, in addition to aircraft.

The Russians, miffed because an invitation to spaceman Maj. Yuri Gagarin was withdrawn to avoid conflict with President Kennedy's arrival, limited their participation to commercial aircraft.

A large number of U.S. commercial and military aircraft, including Navy attack aircraft, the Convair B-58 and the Lockheed F-104, were on display. The U.S. space exhibit, featuring the Project *Mercury Freedom VII* capsule, the first recovered *Discoverer* satellite and a Lockheed *Agena* vehicle, was one of the most popular at the show.

• **Debut for Red Top**—Among the new missiles unveiled at the show was the de Havilland *Red Top,* a British infrared air-to-air missile developed as a successor to the fighter-borne *Firestreak.*

External configuration is similar to that of *Firestreak,* with fixed wings and moving rear control surfaces. Length is 10 ft., 6 in.; wing span, 36 in.; body diameter, 8¾ in. *Firestreak's* infrared guidance system is retained in a more advanced form in *Red Top.* It is housed in a glass nose composed of eight optically flat plates.

The new missile is less tapered at the front than the *Firestreak,* with acceptance of a slight aerodynamic loss to gain in IR transmission. Range of the new weapon is said to be about 9.5 n.mi., a marked improvement over the 5-mi. range of *Firestreak.*

Red Top speed is in the Mach 3 range, and it is capable of collision-course attack in contrast with the pursuit course mode of attack of *Firestreak.* An IR proximity fuse system is carried. *Red Top* has a nuclear or high-explosive capability. Warhead weight is about 68 lbs.

Propulsion is provided by a solid motor unit built by the British government under a classified designation. Security considerations will limit the market for the missile to NATO, Commonwealth countries, and Sweden. De Havilland also is hopeful of some U.S. interest, although *Red Top* does not appear to be a significant competitor with later versions of the Hughes *Falcon.*

Red Top is described as still in development. It has been under flight test at de Havilland's Hatfield plant for several years; while systems checkout has been completed, it still is being tested in the weapon system phase.

The British also displayed for the first time a Bristol Aerojet high-altitude meteorological rocket fabricated almost entirely of glass. The 7.5-ft. rocket will carry an instrument package to a height of 38 miles. Gross weight is 81 lbs.; maximum velocity Mach 4.3.

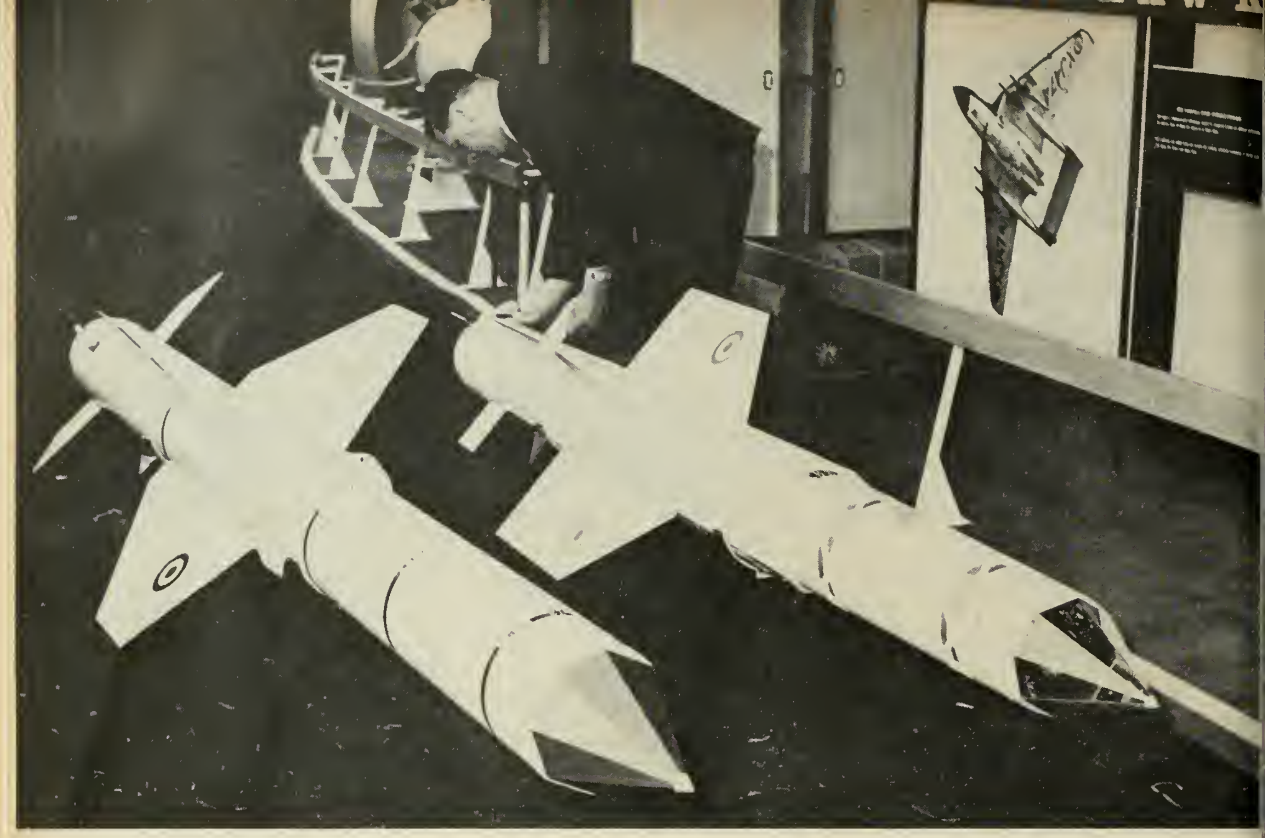
The system is designed with a high launch velocity of 300 ft./sec. to make it safely adaptable to ranges of restricted size. Launch system consists basically of a truck-mounted 38-ft. tube supported on a hinge and raised to firing position by a hydraulic strut. Simultaneously with rocket ignition, a small launch charge kicks the vehicle up the tube.

Payload weight of 10 lbs. can be carried to altitude with 250 cu. in. of payload space. Bristol Aerojet says payload space can be increased to 330 cu. in. by lengthening the rocket 4½ in.

Other British missile exhibits included the Short *Seacat* 2, Bristol/Ferranti *Bloodhound,* and Armstrong-Whitworth *Seaslug.*

• **German entries**—A notable West German exhibit was a small Bolkow two-stage weather rocket, 7 ft. in length

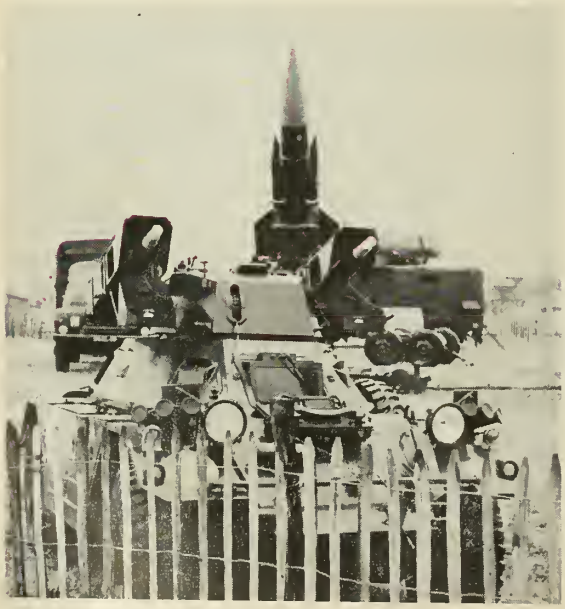
(Continued on page 18)



BRITAIN'S new Red Top missile (left) seen alongside earlier Firestreak. Note aerodynamically cleaner wing shapes and blunter nose.

MISSILES AT PARIS

New Foreign Missiles Dominate



FOREIGN MISSILE displays at Paris featured tactical weapons and sounding rockets—while a government edict prevented U.S. missile firms from showing any offensive weapons except as models. France and Britain, operating under no such ban, went all out to display weapons which they are trying to sell to NATO nations. Result was to make U.S. appear a poor third in the missile displays at Paris.

The small model of the Sperry *Sergeant* which is shown at the far right is typical of U.S. exhibits at the Le Bourget display. British Royal Artillery units, in contrast, arrived with an operational *Thunderbird* battery and the truck-mounted *Blue Water* tactical missile, shown at Paris for the first time. French missiles on display included ASW, surface-to-surface, air-to-surface weapons and target drones. ⁂

TWO VICKERS VIGILANT antitank missiles (left) shown mounted on Ferret. In background, Royal Artillery Thunderbird.



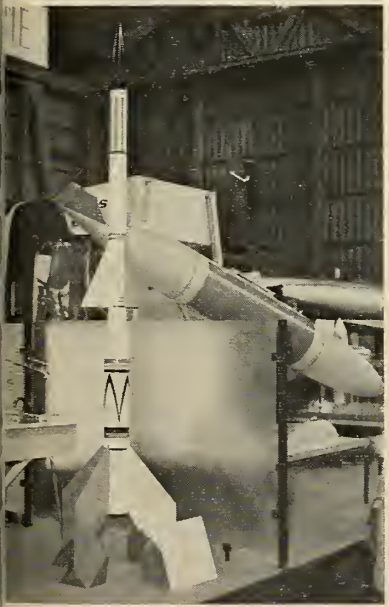
FRENCH DISPLAYS included (l. to r.) C.T. 41 supersonic ramjet target, Masurca surface-to-air weapon, Malafon ASW bird.



BRITAIN'S NEW Blue Water tactical missile was displayed full-scale (above), Sperry Sergeant (below) in 3-ft. model.

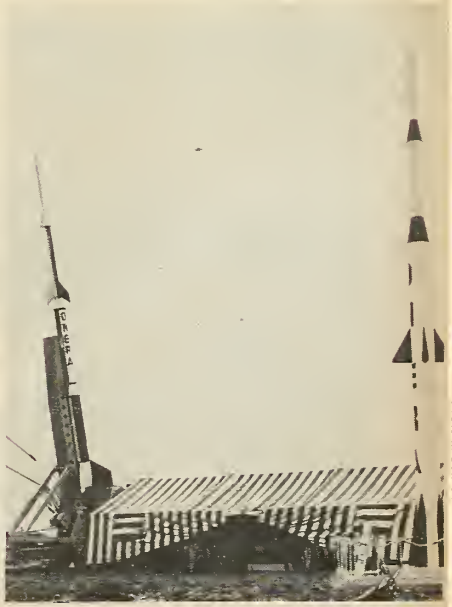


xhibition





SOUNDING ROCKETS displayed included (left) first German rocket shown since the war; (above) British Bristol Aerojet glass rocket; (right) French Antares and Berenice four-stage rockets developed by ONERA, France's counterpart of U.S. National Aeronautics and Space Administration.



Relative Merits of AS-30 And Bullpup Sharply Debated

PARIS—First design details of the Nord Aviation *AS-30* air-to-surface missile, strong rival to the Martin *Bullpup* as a standard NATO weapon, were disclosed at the Paris Air Show.

Like the *Bullpup, AS-30* is equipped with radio guidance, which is proportional control rather than the "bang-bang" type of some versions of the American missile. (The Air Force *GAM-83* version of the *Bullpup* is, however, equipped with proportional control and is available to NATO.)

Unlike the boost-glide *Bullpup,* the solid-propellant *AS-30* consists of a main booster and sustainer to power it into the target.

Length of the *AS-30* is 12.42 ft.; diameter, 13.8 in.; span, 3.28 ft. Total weight of the missile is 1100 lbs. Warhead weight is 505 lbs. The spin-stabilized weapon is fitted with four cruciform wings set at an angle to the longitudinal centerline.

Nord is pushing the *AS-30* mainly by comparing warhead weights with the *Bullpup A,* which is 250 lbs. or half that of the French bird. The company also claims the *AS-30* has—by virtue of its sustainer—a target penetration capability four times that of *Bullpup* at a range of about 7 mi.

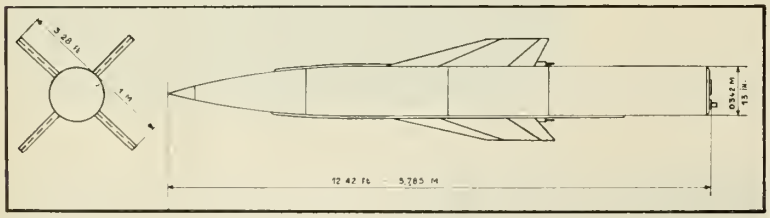
But the warhead of the *Bullpup B* and *GAM-83B* is believed to weigh 1000 lbs. carrying high explosive. Both advanced versions also have a nuclear capability, as does the *AS-30.*

Martin counters the penetration argument by contending that the *AS-30's* speed is slower than the *Bullpup* and that the *AS-30* loses control at sustainer burnout—a factor which would limit the range. *Bullpup* has a separate power system for control to the target.

While a NATO decision was due last week, it is known that a dispute between the British Royal Navy, which favors *Bullpup* and the Royal Air Force backing the *AS-30,* has delayed the decision for another month.

• **Secrecy disadvantage**—Martin felt somewhat at a disadvantage as the competition came down to the wire during the Paris Air Show. The company was under a security restriction and a State Department injunction against showing the *Bullpup.* Nord, on the other hand,

(Continued on page 39)



ABOVE: *Cross-section and lengthwise diagrams of Nord's AS-30 air-to-surface missile.*
BELOW: *An AS-30 mounted under wing (next to fuselage) of Vautour aircraft.*



(Continued from page 15)

and capable of carrying a 17.6-lb. payload to a height of 262,480 ft. Propulsion units are solid motors built by Bolkow. Guidance is inertial with the instrument package returned by parachute. First launch is scheduled from Sardinia sometime in 1962. Perhaps not important in itself, the rocket marks the public return of Germany to the space industry for the first time since the war. More advanced rockets are said to be under development.

Bolkow also displayed its *Cobra* antitank missile, emphasizing advantages of its textile-covered copper wire guidance system over steel wire. The *Cobra* is manufactured in the U.S. for the Marine Corps by Daystrom, Inc. The *Cobra* was shown tank-mounted, jeep-mounted and helicopter-mounted.

• **French potpourri** — French displays showed evidence of a mounting research and development effort on larger, multi-stage vehicles, including the solid-propelled IRBM under development by the Societé pour l'Etude et la Réalisation d'Engins Balistiques (SEREB).

In addition to the land-based missile now in early development stages, SEREB is to receive $1 million and authority to initiate development of the French MSBS fleet ballistic missile similar to the *Polaris.* MISSILES AND ROCKETS learned.

The first French nuclear submarine for this missile is scheduled to be operational in 1968, with the missile itself to be ready in 1969.

SEREB is a consortium of French missile/space firms formed by the government to undertake systems management of all ballistic missile development, as well as space applications of these missiles.

SEREB, with a present corporate staff of 140, is to be increased to 180 by year's end. Sud Aviation disclosed that some 42% of the money now going into the SEREB IRBM is finding its way to Sud, which is charged with re-entry and casing developments.

Societé Nationale d'Etudes et de Construction de Moteurs d'Aviation (SNECMA) is developing the solid propulsion units for all stages of the missile.

Firms taking part in the SEREB program complained that development is being slowed by the ancient government powder monopoly—under which solid propellant grains must be furnished by the government. Due to this situation, it was pointed out, French chemical firms simply are not interested in propellant development.

"France's Space Age is handicapped by a 16th century law," lamented one executive.

(Continued on page 38)

In Missile build-up . . .

Germans Sizing Up Britain's Seacat

by Bernard Poirier

WEST GERMANY is getting ready to evaluate the British *Seacat* ship-to-air missile as part of growing buildup of missile muscle.

Seacat batteries—if the missile is accepted—apparently would be installed aboard new 5000-ton missile destroyers which the West German Navy is being allowed to build.

Permission to amend West Germany's warship limit from 3000 to 6000 tons was granted by the Western European Union (acting under the 1954 Brussels Treaty) just hours before Defense Minister Franz Joseph Strauss revealed an order for 50 *Seacats* May 24.

The tonnage increase has been under negotiation for almost a year. Meantime, the West German Defense Ministry has encouraged Focke Wulf to engage in industrial agreements with Short Brothers, makers of *Seacat*.

It is expected that the Germans will also buy a tactical missile for deployment aboard the destroyers.

The *Seacat* development is the latest in a series of moves designed to arm West Germany with versatile missile power. They already possess air-breathing *Matador* tactical missiles in mobile land units and *SS-11* antitank missiles. It was disclosed last month that the West Germans had placed a $120 million order for Martin *Pershing* tactical ballistic missiles. And they are believed to be eyeing the short-range English Electric *Blue Water*.

The German missile destroyers will be larger than the 3750-ton French ASW missile ship "La Galisonniere" and smaller than the 6000-ton Italian antiaircraft missile cruisers of the "Andrea Doria" class. France's ASW missile is the *Malafon* and the Italian ships will be equipped with *Terrier* missiles.

The coupling of defensive and offensive missile systems is what makes the German design significantly different from those now existing on other NATO or SEATO missile warships. For the moment, there has been no official announcement of a selection of a seaborne ship-to-surface/ship system.

Sea-launched tactical systems of sufficient range, tried and proven, are few. They include the *Regulus* (U.S.), *Malafac* (Fr.) and *Robot 315*, which is used on the Swedish missile destroyers "Halland" and "Smaland."

• **Clear danger**—The compelling factor behind the strengthening of West German forces, along with NATO continental defenses, is of course, the threat of the huge Communist forces immediately to the East.

While other NATO members have territory bordering on Soviet-controlled areas, the strongest Red military threat centers about the Baltic and the line separating the two Germanies.

East Germany apparently has the most extensive military establishment among the satellites. Its Council of National Defense is ruled by the iron hand of Minister-President Otto Grotewohl with the blessing of Communist party boss Walter Ulbricht. It was Herr Ulbricht who, a year ago, rattled off a dozen "locations" of Communist rocket launching sites within striking distance of NATO continental targets.

The East German Ministry of Defense, headed by Gen. Karl-Heinz Hoffmann, administers tri-service activity of the NVA or Peoples Army (Nationale Volksarmee). European sources estimate that East Germany has 125,000 men in uniform, equipped with Soviet tanks, jet aircraft, light artillery and short-range missiles. Main bases are at Neubrandenburg and at Leipzig.

The French intelligence organ *Est et Ouest* estimates the East German Air Force HQ at Strausberg-Eggersdorf has 150 missile-equipped Mig-17 and 50 older Mig-15 jet aircraft plus 200 piston-driven fighter aircraft operating primarily from aerodromes at Cottbus and Drewitz. West Germans say the Soviets have maintained as many as 22

(Continued on page 51)

Seacat Details:

The British ship-to-air Seacat, manufactured by Short Brothers & Harland, Belfast, is standard armament on new Royal Navy Hampshire class ships. The 5-ft. Mach 1 weapon is solid-fueled and has combined radio command/optically coordinated guidance.

West Germany's order for 50 evaluation missiles plus associated equipment marks the fourth successful export effort by the Northern Irish firm. Sweden bought the system as an investigating measure in its program to expand its air-defense Naval rocket program.

Seacat is being outfitted on New Zealand's new "Otago" and "Taranaki" frigates and Australia plans similar deployment for the system, which can give antiaircraft coverage to a 43-sq.-mi. area.

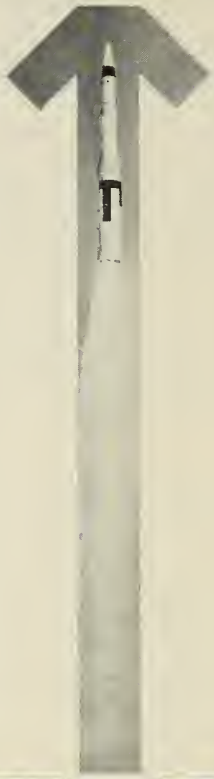
Radio command for the four-missile shipboard battery is believed to be an Elliott Brothers (London) development. For use in a "chips down" situation, the system is man-controlled from the time a target is sighted to its destruction. Seacat's mission is "close-range defense, for use when hostile aircraft have penetrated a naval unit's outer defenses and escaped weapons of greater range."



A two-man battery crew uses binoculars to lock on a target. Aimer's movements of the shackled binoculars cause automatically coordinated movements of the missile launcher—thus keeping the radar dome, centered between four Seacats, zeroed to the same reticule as the field outlined in the binoculars. Radio impulses track the aircraft and guide the Seacat missile into coincidence until a hit is scored.

Independent observers predict Seacat will be Britain's top missile export because of the weapon's high reliability. Focke Wulf G.m.b.H. of Bremen was designated last year as local servicing and system agent for an eventual German test program. The last roadblock to the $85 million Bonn purchase was lifted when the Western European Union agreed to raise the weight limits on German warships (see story). If the missile proves suitable, joint development by Short Brothers and Focke Wulf is envisaged.

Join the Minutemen of Space Technology Leadership



MINUTEMAN

In 1957, the Air Force Ballistic Missile Division, now the Ballistic Systems Division, awarded Space Technology Laboratories, Inc. a contract to study the feasibility of a solid propellant, multi-stage Intercontinental Ballistic Missile. When that study demonstrated that such a missile system was technically feasible, STL was awarded a contract to provide systems engineering and technical direction for the program to bring the system into being.

Design criteria for the system and its subsystems were prepared by STL as a member of the industry team which, under the leadership of the former Air Force Ballistic Missile Division, set about the task of creating the Minuteman system. Guided by the principle of concurrency and spurred on by the same appreciation of urgency which marked the development of those other Air Force weapon systems in which STL performed systems engineering and technical direction — Atlas, Thor and Titan — this industry team met the rigorous time schedule established for the program. The first captive test of the missile was made on 15 September 1959, the exact date scheduled eighteen months earlier. The dramatically successful first flight test at Cape Canaveral on 1 February 1961 occurred within weeks of the programmed date.

The Minutemen of STL are proud of their role in the development of the Minuteman system, and of their association in that program with: Boeing Airplane Co. (assembly and test); Autonetics Division of North American Aviation (guidance and control); Thiokol Chemical Corp., Aerojet General, and Hercules Powder Co. (propulsion); and Avco Corp. (re-entry vehicle).

Minuteman has passed its first research and development flight test. Ahead lies the work of completing the ground system and missile development, and of bringing the system to operational readiness. These tasks require qualified engineers and scientists to augment STL's Minuteman team in both Southern California and Cape Canaveral. Those capable of contributing to this important program in Space Technology Leadership are invited to write Dr. R. C. Potter, Manager of Professional Placement and Development, at either location.

SPACE TECHNOLOGY LABORATORIES, INC. P. O. BOX 95005F LOS ANGELES 45, CALIFORNIA

a subsidiory of Thompson Romo Wooldridge Inc.

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Technical Countdown

ELECTRONICS

Non-rotating Gyro in Development

A spectacular improvement in missile/space guidance systems may be offered by a new non-rotating gyro. The device, which uses a tuning fork as a sensing element in place of the conventional rotor, is reportedly in working-model stage at Gulton Industries. The tuning fork, excited by an electromagnet, seeks to maintain its position in space as does an ordinary gyro and can sense any change in its platform's position. Useful life of the device is limited only by the life of its electronics—making it a strong contender for applications in siloed missiles and far-space vehicles.

Power Group Expands

Membership of the Inter-Agency Advanced Power Group has been broadened to include NASA, AEC, and ARPA. Formerly the Interservice Group for Flight Vehicle Power, IAPG is expanding its work in "unconventional" power sources and now supports a newly established Power Information Center. PIC will serve as a technical secretariat for government and industry in the energy conversion field.

High-power UHF Xmtr for Space

A 1-to-2-kw ultra-high-frequency (200-400 mc) transmitter for space use has been developed by Space Electronics Corp. Designed to operate efficiently throughout the entire range of expected environmental conditions experienced by missiles and spacecraft, it is believed to be the first high-power UHF transmitter designed to fulfill such rugged requirements. Completely potted in a 4.5-in.-dia. x 13-in.-long cylinder, the unit will operate "at least to 400 or 500°F," the company says.

Suppressor Kills Space-relay Echo

An "echo suppressor" designed to solve one of the basic problems of space communications has been developed by General Telephone. The device is designed to silence echoes which would occur in telephone conversations relayed by space satellites between widely-separated parts of the world. These undesirable echoes of an individual's voice would cause a speaker to enunciate too slowly and jerkily, and interrupt trains of thought, making conversation unsatisfactory or even worthless.

Earth-path Communications Show Promise

Ranges of 50-100 miles for radio transmissions through underground rock strata are expected to be reached in the next year. Researchers at Raytheon already have shown experimentally that 200-kc signals are detectable at distances of up to 18 miles with 100 watts radiated power.

UV Communications Feasible for Space?

An ultraviolet transmitter can provide narrow-band communications over a range of 50 megamiles with one watt radiated power, according to scientists at Westinghouse Air Arm Division. This range may be increased up to five times, they say, with optimization of design and materials.

Wide Range of Vibrations Tested

A test device capable of simulating missile vibrational environments—varying in range from those of a rolling and pitching destroyer to actual blast-off—has been built by Convair-Pomona. The system was developed because of the need for more adequately testing complex vibrations and shock produced by tactical weapons (the division produces the Navy's Advanced *Terrier, Tartar,* and the Army's *Redeye* and *Mauler*). The hydraulically actuated system was built, Convair said, because such an instrument was not available commercially.

Premium Transistor Program Started

RCA has initiated a premium transistor program to provide quality and reliability information on high-volume transistors used in computers. Under the program, commercial transistors will be tagged with comprehensive electrical, mechanical, environmental, and life data so complete, the company says, that the customer will not need to write his own specifications.

ASTRONAUTICS

Man Better Than Machines

Man will be worth more to a space flight system than the machines required to take his place, according to new results of Martin's initial feasibility study on the *Apollo* spacecraft. The study showed that man's most indispensable contribution would be his in-flight decisions. By being on board, he can evaluate flight phases and react to emergencies far more efficiently than either automatic controls or decisions relayed from earth stations.

Brain Damage from Weightlessness

Possible effect upon the brain from extended space flights has been evidenced in animal experiments with extended periods of weightlessness. Brain area most affected is so-called "sleep center." Also, exposure to certain continued vibrations is believed to contribute to brain damage leading to loss of judgment abilities and, in extreme conditions, even loss of consciousness. Researchers are attempting also to learn more about thresholds of radiation where the brain begins to show abnormal electrical patterns.

Space-vehicle Loading Critical

There is no apparent recognition of the problems associated with inflight determination of mass data or energy reserves during manned space flight, warns C. J. Holden, head of Spacecraft Weights Section, Aerospace Corp. He urges development of techniques for "managing" spacecraft weight during flights—particularly where future missions involving multi-orbital transfers are concerned. He said situations would arise in which astronauts—like seamen and airmen—would have to take "emergency jettisoning or load transfer measures" to assure safe return to earth.

PROPULSION

Phoenix Used for Chaff Launchings

In its first operational firing on the East Coast, the Rocket Power *Phoenix* recently lifted a 12-lb. chaff payload from Wallops Island, Va., to an altitude of 170 miles. Five more launches are planned in the series for Patterson-Moos Corp. and the Air Force.

STEPS Solar-power System to be Tested Soon

Built by GE for Air Force, it is first solar-thermionic system near hardware stage; new test facility goes up

by William Beller

A SOLAR-THERMIONIC system designed as a lightweight source of kilowatt power for advanced satellites is expected to be ready for test by midsummer. Flight testing is expected by 1963.

This will be the first such system to reach the developmental hardware stage.

Called "STEPS"—an acronym for Solar Thermionic Electric Power System—it is being built to demonstrate feasibility. The first system is sized to deliver 500 watts of continuous power in a space environment.

Later systems will develop from three to ten kilowatts, if STEPS works as planned. Within this power range, the specific system weight based on using thermal energy storage is estimated to be between 150 and 200 lbs./kw. If these figures are accurate the solar thermionic power system probably will weigh less than any other solar-powered system operating in the low-kilowatt range.

STEPS is being developed by General Electric's Missile and Space Vehicle Department under a $300,000 contract with the Air Force's Aeronautical Systems Div.

GE is erecting a Solar Test Facility in Phoenix, Ariz., specifically designed for testing solar-powered APU's (Auxiliary Power Units). The facility's sole building is track-mounted in order to regulate a system's exposure without moving the system. The company says that there will be over a million dollars worth of test equipment at the site.

STEPS will be the first APU to be tried out at the new facility.

• **How it works**—STEPS is composed of a collector—a parabolic reflector—which focuses the sun's rays on a generator made up of many thermionic converters, and several subsystems.

The collector is used to concentrate the sun's incident energy of 0.14 watts per square centimeter to the ten watts per square centimeter or more needed on the cathode surfaces of the thermionic converters.

The thermionic converter operates in principle like the conventional vacuum-tube diode. Electrons are boiled off a hot cathode, pass through a space gap onto a relatively cool anode. From here, the electrons—as an electric current—flow through a load where they perform work and return to the cathode. The heat on the cathode comes from the sun's rays which had been concentrated by the collector.

Rather than merely focus the sun's energy directly on an array of converters, GE uses a hollow cavity—called a generator—as the target. The thermionic converters are mounted in the walls of the generator, picking up their energy from inside the cavity and discarding waste heat on the outside.

The sun's energy enters an aperture in the generator, where it is contained and reflected, except for some that slips back out through the aperture. This minimizes the amount of energy lost.

• **A sun-seeking collector**—Two solar-cell sensors help orient the collector so that the sun's rays fall parallel to the axis of the reflector. One cell senses an azimuth error, the other an elevation error. These feed corresponding drives on the space vehicle, whose attitude is then suitably changed by a torque-producing device such as a flywheel, gas jets, or perhaps by an ion engine.

When the vehicle emerges from a planetary shadow into light, the collector is disoriented for a short time. Thus the sun's rays may momentarily be focused on the surface of the generator and burn it up. To prevent this, a heat shield is set in front of the generator.

It has been proposed that a quartz window fill the generator's aperture. This would make the cavity a miniature greenhouse, but it would cut down the amount of energy entering the cavity. The idea is still being evaluated.

STEPS is being designed to operate with nickel-cadmium battery storage. Later versions may be adapted to use thermal or fuel-cell storage systems.

The present version is being developed to work in a cycle of 55 minutes light, 35 minutes dark. GE engineer David L. Purdy says that the system will have an efficiency of 5%; the battery-charging efficiency—ratio of battery power output to battery power input—will be 68%.

Comparison of Converter Types

VACUUM	VAPOR
Close spacings .0002-.0004 in.	Large spacings permissible .001-.040 in.
Present efficiency 4%	Present efficiency 7%
Future efficiency 6-10%	Future efficiency 10-20%
Long range expected efficiency 15%	Long range expected efficiency 30%
Hot side temperatures 1100°C-1300°C	Hot side temperatures 1700°C-3000°C
Vacuum interior	Cesium filled
Devices now being manufactured	Research prototypes built but production units not yet available
Power density .5 watts/cm²	Power density 10 watts/cm²

Over 160 sq. ft. of collector will be needed to provide the 500 continuous and regulated watts in space. To deliver this much space power, a collector nearly 16 ft. in diameter is needed. Before fanning out to this size in orbit, the collector will be housed in a 10-ft.-diameter cylinder.

• **Ground-based model**—The STEPS to be tested in Phoenix will be connected to a simulated vehicle and from this, to a ground-mount pedestal. Through a sensing system and motors in the ground pedestal, the collector will be suitably oriented.

The ground collector system will deliver 540 watts to the ground storage and regulation systems. This figure is the product of the power impinging on the collector and the efficiencies of the collector and generator systems. Of this power, a little less than half will go to the load, and the rest to the storage system.

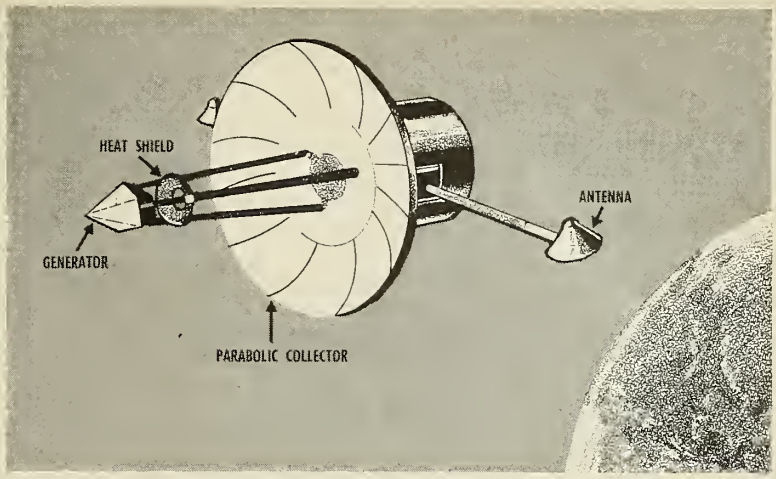
This is far from the 500 watts the system is designed to deliver to the load on a continuous basis under orbital conditions; the reason is clearly a result of the reduced solar constant at ground level.

The thermionic converters being used in STEPS are the vacuum type. This is a less efficient converter than the vapor type, which is only now emerging from the research phase. When it is in production, it will be interchangeable with the vacuum type.

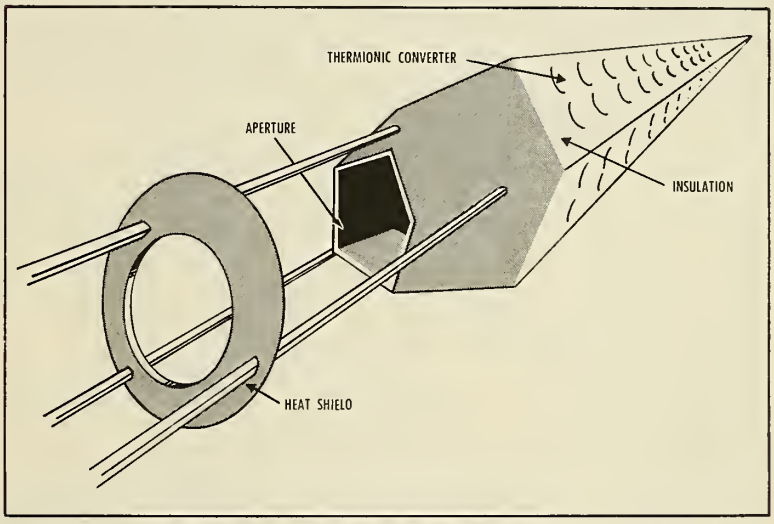
The interelectrode gap in the vapor converter is usually filled with cesium gas. Its purpose is to reduce the space charge, thereby permitting a greater quantity of electrons to migrate from the cathode to the anode. In effect, the gas acts like a space-charge grid. This improvement is highly significant, and could result in a converter having double the efficiency of the present-day one.

Yet all is not rosy for solar thermionic systems. Their chief drawback is that reasonable system efficiency demands unusually high accuracy in collector-surface orientation with respect to the sun. William C. Cooley, NASA's chief of advanced technology, estimates that an angular accuracy of better than 0.1 degree is required.

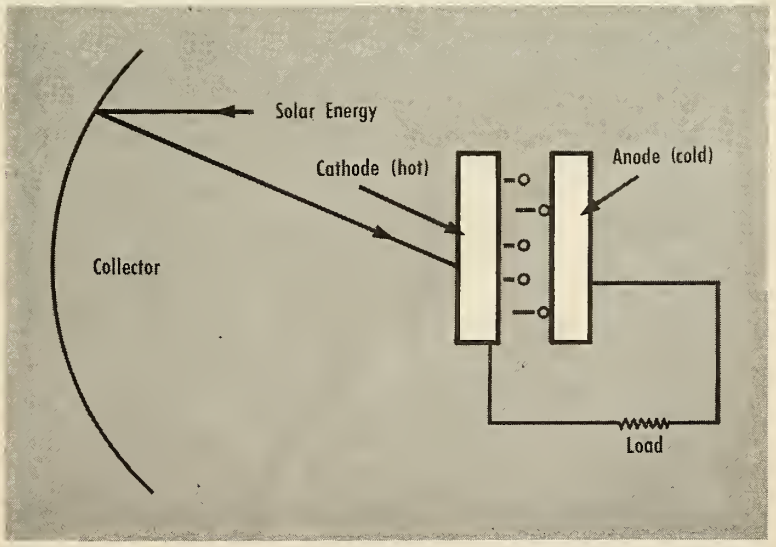
Despite this engineering problem, the civilian space agency is still highly interested in developing thermionic power for space applications. The Jet Propulsion Laboratory is preparing to let out a contract for a solar-thermionic module, identified by the code name "SET." Expected to be equipped with a four-to-five-ft.-diameter parabolic collector, each module will be designed to put out about 130 watts and be capable of clustering for larger power outputs. ⌘



ARTIST'S CONCEPTION of GE's 500-watt STEPS operating in an earth orbit.



CLOSE-UP of generator. When present, cesium gas minimizes the space charge.



ELECTRONS boiled off cathode by solar energy migrate to anode and back to cathode.

Humphrey Hits Obsolete Data Handling

Senate subcommittee report cites lack of interagency indexed inventory—even of central file at NASA

MANAGEMENT of scientific information in the U.S. is being handled on a "Model T" basis, Sen. Hubert H. Humphrey (D-Minn.) has declared, and such obsolete methods contribute to duplication and "tragic and intolerable waste of men, money, and material."

Humphrey's statement last week was based on a study of the coordination of scientific information on current research and development work. The results of the study, conducted by a Senate Government Operations Subcommittee of which Humphrey is chairman, have just been released in a 278-page report.

The report blasted the lack of an indexed interagency information inventory of some 160,000 R&D projects—which amount to over $8 billion annually. Humphrey noted that there are various uncoordinated systems among various agencies. But these, he said, are a "hodge-podge"—"overlapping, underplanned, under-nourished, and underused."

The urgency of better information management is especially critical, Humphrey concluded, in our man-in-space program. This program's entire pace and success depend on mastery of up-to-the-minute information on current R&D projects, he said. It cuts uniquely across many different disciplines, agencies, laboratories, and scientific organizations.

According to the report, NASA does not even have a central index of all its current in-house and extra-mural R&D projects. For the Federal Government to rely on present methods of information storage and retrieval is "no way to run a railroad—or a race for survival."

The report deals primarily with information in the pre-publication stage—that is, current information on work in progress. Humphrey points out, however, that even the management of published literature is far from adequate. And "scant" attention is being paid to the masses of data accumulating on work in progress which, the report said, may remain relatively unknown for years—and, sometimes, forever.

"Lost effort" and unknowing duplication were also criticized in the report, which states that more than $2 billion in contracts were cancelled in the last three years—and that much of the data gained in this cancelled work was irretrievably lost. Full recovery of such information would represent a 12% increase in manpower.

Due to the lack of available information on past progress, the report estimates, unintentional duplication runs as high as 10% of total effort.

The report points out a clear mandate to both the President's Federal Council for Science and Technology and the National Science Foundation to provide for "more effective dissemination of scientific information and undertake programs . . . for making scientific information available." But, the report says, nothing concrete has yet come out of such directives. The role of NSF "to exercise leadership in coordination is clear."

• **Findings and recommendations**—Results of the committee study were presented as a series of findings and recommendations.

1) Strong Federal policy—The need exists—both for purposes of administration and for conduct of the nation's expanding R&D enterprise—for a reliable system for information on proposals, work in process, work completed (and results unpublished), and projects terminated short of completion.

Recommended: The Special Assistant to the President for Science and Technology and the Federal Council for Science and Technology should devote increased attention to coordinated interagency planning and management of scientific R&D and to the utilization of up-to-the-minute information therefor.

2) Strengthen SIE—The Science and Information Exchange should vigorously pursue planning studies already under way and conduct whatever new studies are necessary to secure optimal results from the SIE.

3) Continue documentation efforts—Since SIE is not per se a documentation center, all Federal documentation centers—particularly, Armed Services Technical Information Agency (ASTIA) and Office of Technical Services (Dept. of Commerce)—should continue and expand their efforts and cooperate with each other and SIE.

4) Increase role of Professional Societies—Professional Societies can render an invaluable service in disseminating information on research in progress. Therefore, SIE and other agencies should strengthen their cooperation with them.

5) Determine information costs—More should be known about expenditures for organized management of scientific information. NSF and the Federal Advisory Committee for Scientific Information should continue efforts to determine Federal outlay for scientific communication and information purposes and should receive fullest cooperation from the agencies.

6) Convert research into improvements—NSF and DOD studies have laid a firm foundation for understanding on which to build improved information services for scientists and engineers. But still far too little is known to improve existing information and documentation systems and changes in information gathering and utilization techniques.

7) DOD conduct internal review—DOD should move ahead in resolving policy and operational problems of information systems and activities.

8) Information a line item—Financing of SIE should be a budget line item for Congressional review. It could be a specific part of a larger item on management of pre- and post-publication scientific information or included in appropriation bills for NSF or HEW.

9) Strengthen manpower analysis—specific part of a larger item on manpower is a valuable asset to the nation. The Federal Council for Science and Technology should devote further attention to the problem of strengthening manpower information.

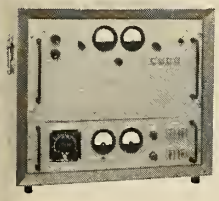
• **No panacea**—In Sen. Humphrey's words, the report offers no panacea. It "merely offers one limited but, we believe, significant approach. To my way of thinking it suggests, in effect, a nation-wide complex of integrated systems on pre- and post-publication information. Purpose of the complex would be to permit rapid-fire exchange of indexed data on work in progress and work completed.

"What this report does is submit to science a tool for science. It seeks to harness a 'revolution'—for storage and retrieval of information on prepublication work.

"The choice is ours. We can either master the 'revolution'—or allow it to pass us by and, thereby, lose that which can never be regained—time." ⁂



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Working on the principles of optical pumping and transmission monitoring, the rubidium standard is recommended for continuous year-after-year operation. The heart of the system consists of two ultra-reliable elements: a long-life rubidium lamp and an all-glass rubidium vapor absorption cell. Design emphasis is on dependability throughout.

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BOOSTER GRAIN for Tartar is weighed and inspected after being stripped from mold with core still intact.

propulsion engineering

New Tartar Motor Now in Production

Dual-thrust Aerojet solid powerplant utilizes latest high-energy propellants to enhance missile performance

NAVY'S unique new dual-thrust solid motor for *Tartar* has just gone into production at Aerojet-General's Sacramento plant.

The improved motor, which combines both booster and sustainer in one unit, passed its operational status test in April with the successful kill of a jet drone 20,000 feet over the Atlantic.

The motor's built-in "overdrive" capability furnishes a high initial energy level for liftoff thrust, then burns at a slow rate as a sustainer. The dual-thrust dual-grain solid propellant is the first of its type to go into production for the Navy.

Stringent dimensional limitations of the *Tartar* required new solutions to achieve the desired ballistic performance of the solid-rocket motors. These problems were successfully overcome by incorporating the bi-propellant dual-thrust grain to serve both as booster and sustainer.

• **Design problems**—It was decided at the outset of the *Tartar* design program to use the combination propellant contained in a single chamber. Such a design, however, involved several major problems:

—A successful means of casting the bi-propellant grain to achieve a suitable bond from booster propellant to sustainer propellant, from sustainer propellant to chamber liner, and from chamber liner to chamber wall.

—Selection of compatible propellants, and the design of a propellant configuration which would provide the ballistic performance required.

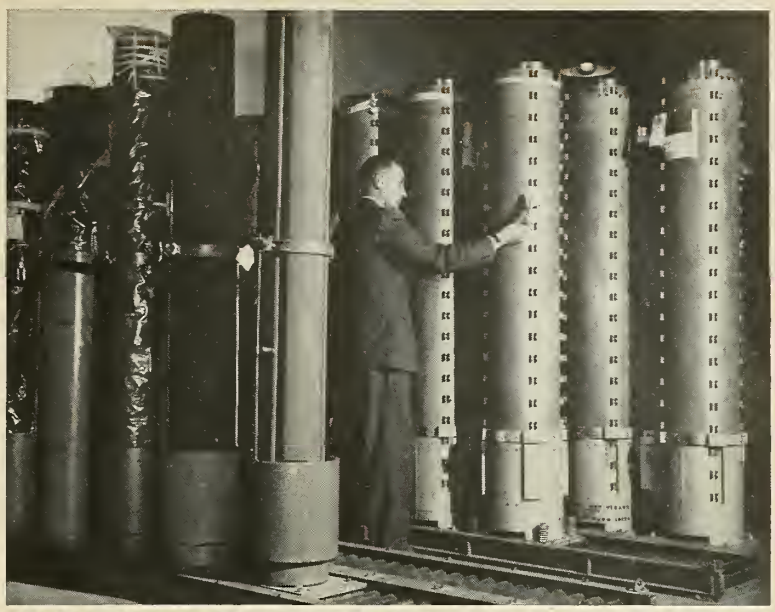
—Development of a nozzle extension tube that would remain within stringent dimensional and thermal limitations of the missile envelope, and be capable of withstanding the severe erosive action of the propellant exhaust gases. The extension tube was required since the missile design called for space at the missile's after end for several important components. Extension tubes for solid rockets had been designed before, but none equal to the extreme heat that would be encountered in *Tartar* motor operation.

Special tooling had to be devised to cast the bi-propellant grain, manufactured through a new technique called "displacement casting." Exact centering of booster grain is especially critical.

The Navy says the new propulsion system has many advantages over the two-stage unit. It is simple, and therefore more reliable. There is only one ignition system, fewer metal parts, and



MOTOR stands in curing room after displacement casting.



MOTORS FOR TARTAR are inspected and tagged before leaving cast and cure area. Booster grains in foreground await displacement casting of sustainer propellant.

the attachment and separation system is eliminated. Overall safety of the weapon system is improved due to elimination of the possible hazard from a falling burned-out booster case.

Shipboard logistics and storage problems are eased because the missile occupies much less space than others now in use. The complete weapon is approximately 15 ft. long and slightly over a foot in diameter.

Aerojet is developing an improved *Tartar* propulsion unit which will use a higher-energy solid propellant and improved inert parts. This new motor will further increase the missile's performance capability.

Work on the basic *Tartar* motor began in mid-1956, under the direction of Navy's Bureau of Ordnance. It entered production in March, 1960, and will phase out of production this year when it is replaced by the improved motor.

The improved motor development program began at Aerojet's solid rocket plant in mid-1959, and entered the production phase in May, 1961.

Newly developed high-energy propellants increased performance during the sustainer phase operation of the improved motor by about 25% over that of the basic *Tartar*, resulting in greater range and altitude capability.

To date, the Navy has launched two guided missile destroyers which will be armed with *Tartar*. The USS John King was commissioned in February, 1960. The first, USS Charles F. Adams, was launched in 1959. ⌘

New Sparrows to Have Solid Motors After All

ADVANCED *Sparrow III* air-to-air missiles will have solid rather than prepackaged-liquid propulsion systems.

Navy has awarded a $675,000 contract to Rocketdyne Division of North American Aviation Inc. for developing the high-powered solid motor. Previously announced plans for a prepackaged-liquid motor to be built by Thiokol Chemical Corp. apparently have been dropped.

Rocketdyne officials say the new solid motor is to be uprated substantially over the 1500-plus-mph speed of present *Sparrows*. The work will be done at the division's McGregor, Tex., plant.

Raytheon Co. is prime for *Sparrow*, a radar-homing bird 12 ft. long and 8 in. in diameter with a high-explosive warhead. It weighs 400 lbs. Operational with Navy and Marine fighter units, latest versions have a range of more than 5 nautical miles. ⌘



EARLIER VERSION of Raytheon Sparrow flies under wing of Navy F7U jet fighter.

Goodrich Emphasizes Superior Sma

Company not interested in big booster market; series of C-523 propellants, with excellent temperature resistance, is highly regarded

by Frank G. McGuire

RIALTO, CALIF.—B. F. Goodrich Aviation Products, concentrating for the present on the small-rocket-motor market, has developed a family of high-density, high-impulse, low-cost solid propellants with superior physical properties and availability.

The company's solid rocket plant here can produce large batches of the C-523 propellant family and loading motors of 2000 lbs. gross weight. But it is shying away from the large booster field now attracting most other firms in the propulsion business.

Frank R. Carvell, general manager of the plant, told M/R his facility is currently turning out a variety of propellants for *Loki, Asp,* and other small rocket motors, with 500 lbs. gross weight as the general upper limit of operations.

Production of the Rialto operation is now centered about polybutadiene-acrylic acid, polyurethane, nitrosol, nitro C-rubber and other propellants, as well as pilot production of research propellants developed in the facility laboratories.



X-RAY FILM of motor containing the new C-523 propellant mixture is examined by product engineer David Y. Miller and plant manager Frank R. Carvell at the Rialto solid rocket facility.

The C-523 nitro C-rubber series, (M/R, April 24, p. 7) is a mixture of Hycar man-made rubber with high-energy compounds and ammonium perchlorates. Its specific impulse is reportedly over 250 seconds—15 seconds higher than comparable rubber-based fuels.

Carvell said development of the C-523 family began with Air Force funding and continued under B. F. Goodrich financing after the Air Force was forced by budget problems to withdraw. Although the propellant has growth potential, its theoretical maximum specific impulse is not as high as other solid propellants, he added.

• **Better at extremes**—However, C-523, which is merely in a class with other high-energy double-base composites such as nitrosol at room temperatures, is claimed to be vastly superior at both temperature extremes. Aviation Products says it will stand longer durations at higher temperatures than any other such composite, and its operating range includes temperatures which cause auto-ignition in other propellants.

Archie B. Japs, Technical Manager for Rocket Motors at the facility, added that the burning rate of the C-523 series is far less affected by chamber pressure and temperature than similar propellants, and it is far safer to handle. Its density is higher "by several percent" than comparable formulas, Japs reported.

The ready availability of raw materials for the C-523 series is a major factor in its desirability. Goodrich officials said, noting that the high-impulse propellants now being most heavily researched are sensitive to many variables and require expensive and hard-to-get raw materials.

Japs said chamber pressures only above 200 psi have been tested with the C-523 propellants, but there is no reason lower pressures cannot be utilized with the fuels.

Other propellant research at Rialto has produced polyurethanes with burning rates at least 25% less than any comparable composite medium-energy propellant, and a nitrosol-type propellant with extremely favorable physical properties.

B. F. Goodrich anticipates that the C-523 series will be used in tactical military missiles, as well as in sounding rockets and other smaller vehicles. The great density makes it possible to pack more propellant into a smaller space, allowing compression of the vehicle envelope with no sacrifice in impulse. The temperature operating range of the series, −110°F to +250°F makes it very useful in military requirements. Its bonding and retention of physical properties over the range are excellent, Carvell commented, and the high mass ratio possible with a dense propellant opens up a considerably great number of

olid Motors

space applications and satellite missions.

• **Plant history**—B. F. Goodrich Aviation Products, which entered the composite solid propellant research field in 1952, now has 160 acres outside Rialto, near San Bernardino.

The company, awarded an Army contract in 1953, was first to demonstrate the merits of specially tailored urethane polymers and carboxylic acid copolymers as binder-fuels for composite propellants. Result of this success was the purchase of a former explosive plant, now the Rialto facility, in 1957, to continue research, development and production.

The plant, in its work for the Air Force, has come up with a number of propellant formulations for use in large boosters and sustainers.

• **Product range**—Goodrich is now manufacturing a family of polymeric materials to be mixed with oxidizers and cast into rocket motors to provide high efficiency and strength.

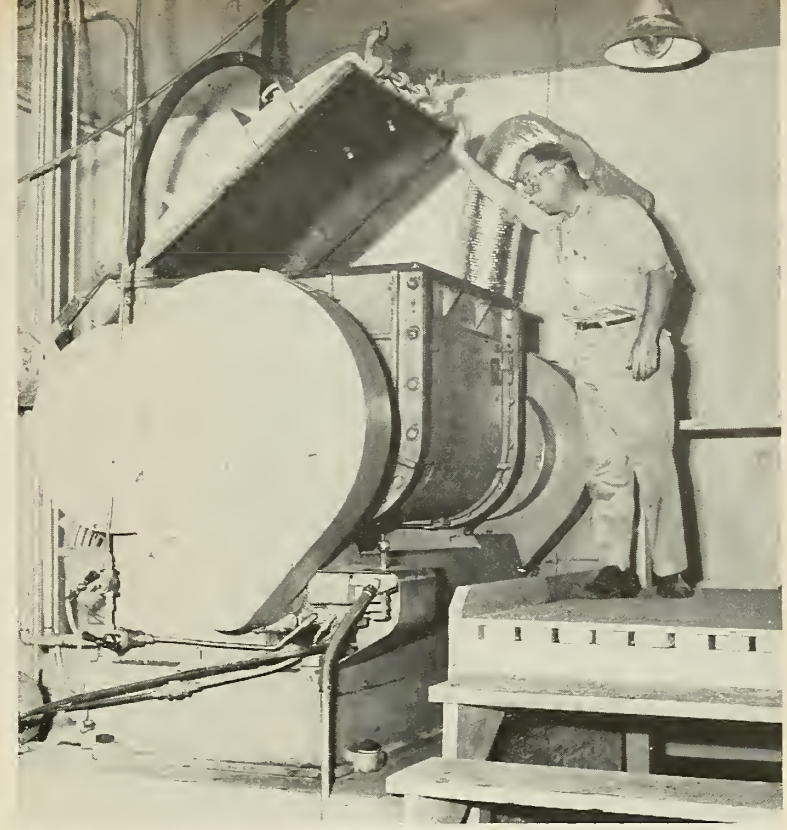
Castable polymers being produced include copolymers of two or more components containing free carboxyl groups curable with epoxy resins and polyurethane "pre-polymers" curable with polyol crosslinking materials. The latter are of interest because of their low viscosity and resistance to heat release and shrinkage during cure.

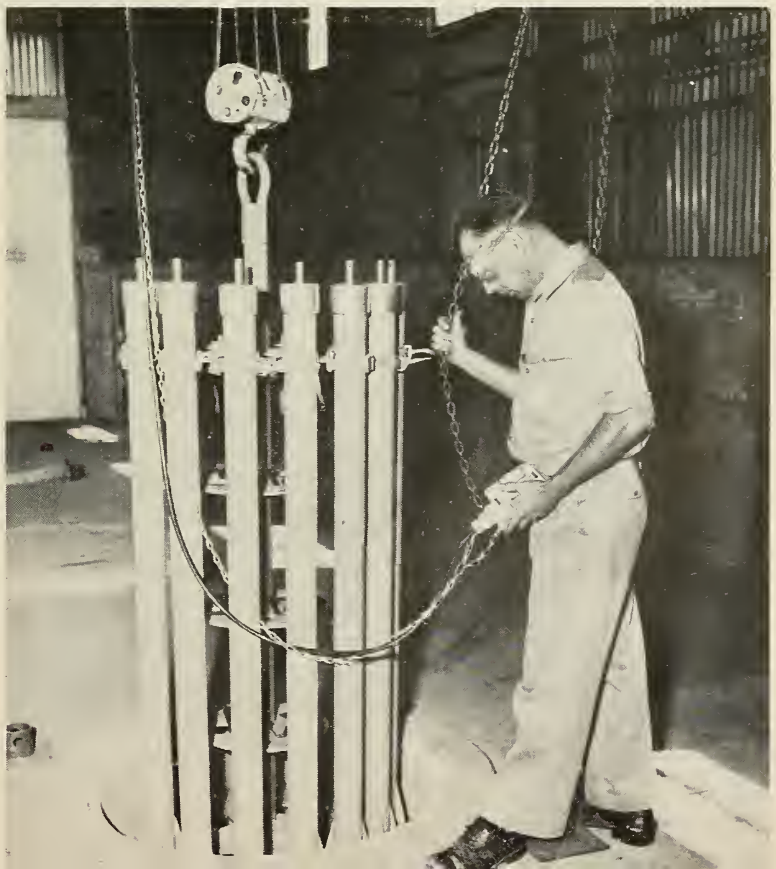
Extrudable or moldable polymers are produced in solid form and include copolymers of two or more components with free carboxyl groups curable by use of a metallic oxide, and polyurethanes for mixing with crosslinkers and then mixed by conventional techniques for solid or viscous materials.

In addition to producing propellants, the company designs and supplies hardware components for rockets, including motor cases and nozzles. A sizable capability for production of filament-glass-wound rocket casings has been developed at other Goodrich plants.

Several versions of small glass rocket casings have been loaded at the Rialto facility as part of a research study of materials and propellants.

As part of the corporate complex of research facilities, the Rialto plant can call on the B. F. Goodrich Research Center at Brecksville, Ohio, or the Chemical Development Center at Avon Lake, Ohio, for additional support. ⌗





ABOVE: *A 100-gallon mixer, remotely controlled, is used in production of solid propellant.* **BELOW:** *Small rocket motors are lowered into a curing bay for controlled heat application. Maker says C-523 is vastly superior in extreme heat.*

Army Gets New Communication Systems

Powerful compact units to provide limited-war communications direct from field commanders to the Pentagon at ranges up to 7000 miles

PROTOTYPE units of Army's new air-transportable communications systems—called the world's most powerful and compact—have been delivered to the Signal Corps. The systems were publicly demonstrated for the first time last Thursday at Ft. Myer, Va.

Built by Adler Electronics, the units can be flown to any world trouble spot and set up for operation in a few hours. The TSC systems use high-frequency single-sideband radio to provide field commanders voice and teletypewriter channels direct to the Pentagon at ranges up to 7000 miles.

The systems, built in three different sizes to fit varying situations, fit into STARCOM, Army's global communications network. The most powerful of the three can bypass or back up a STARCOM station during an emergency.



TSC-20 COMMUNICATIONS SHELTER provides field commanders with a direct link to the Pentagon. The one-kilowatt station has a range of up to 2500 miles.

The new radio centrals are highly miniaturized and the Army says they provide the reliability and range formerly possible only with large fixed installations. The systems, completely self-sufficient, are made up of modularized packages put together on the spot to provide a complete communications facility.

The TSC centrals use single-sideband (SSB) transmission for its simultaneous use of multiple information channels and increased power over conventional methods. Dual diversity reception—the use of spaced antennas and special receivers—provides continuous high-quality signal reception. Operation is fully duplex for simultaneous transmission and reception.

• **Three models**—The most powerful of the three TSC systems is the 40-kw TSC-18. Consisting of a trailer and three small shelters, it provides three voice and 16 teletypewriter communications channels with a 7000-mile range. It can be set up and ready for operation in eight hours.

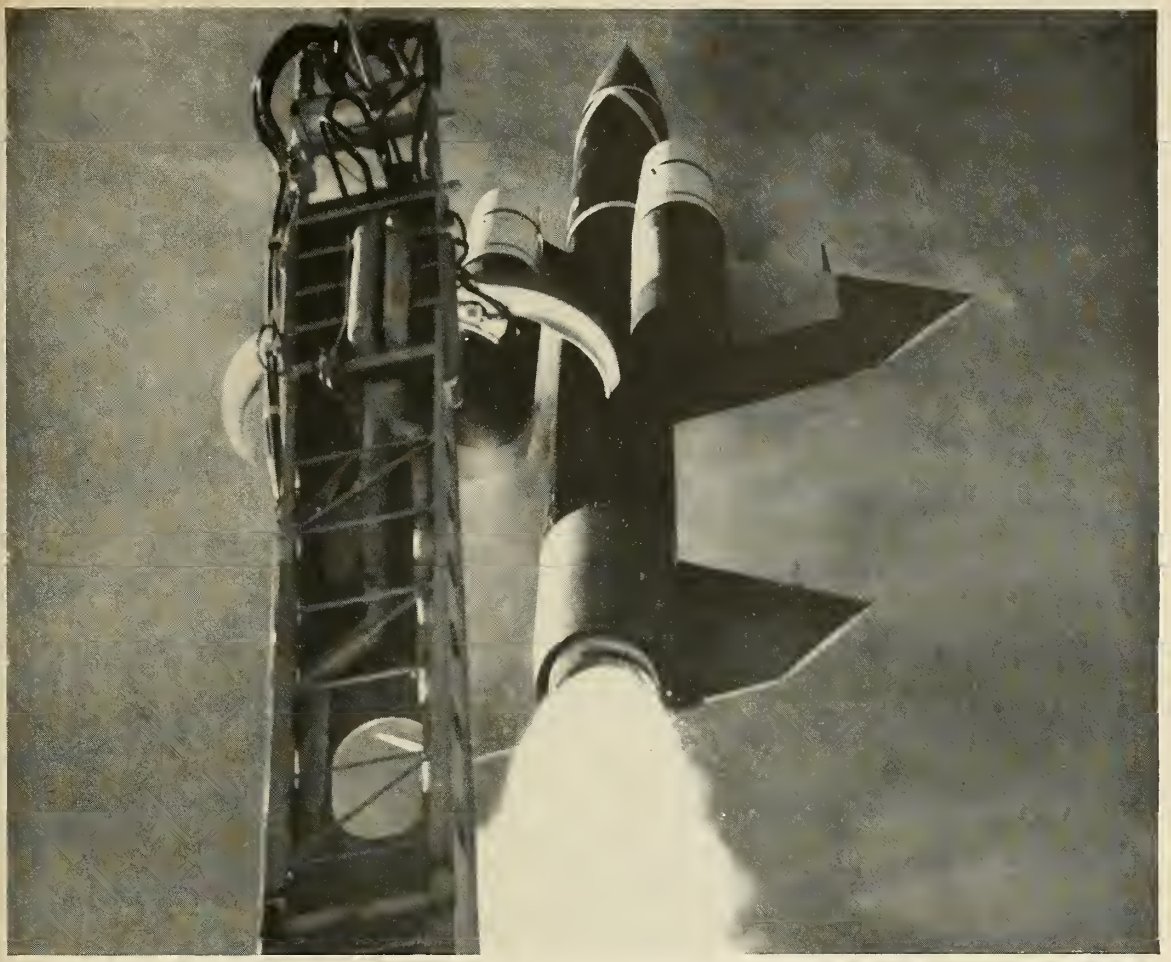
The 10-kw TSC-19, housed in four small shelters, offers the same channel traffic capacity with a range of up to 5000 miles. It also requires a set-up time of only eight hours.

The 1-kw TSC-20 consists of a small shelter and two subscriber packages for remote operation. It can be erected in two hours for communications on one voice and eight teletypewriter channels with a range of up to 2500 miles.

Each subscriber package contains a telephone set, a teletypewriter set, and cryptographic facilities. They can be used as a terminal station to interconnect major command posts, or as a terminal station using the TSC-20 shelter as a relay link to the STARCOM system.

All the TSC stations include antennas, power generators, standby equipment, spare parts and tools for operation and maintenance. The shelters are lighted, heated, air-conditioned, and human-engineered for optimum operating conditions for personnel and equipment.

Cost of the three prototype systems was approximately $900,000. ⁂



AUTOMATIC SKY FIGHTER. Supersonic Boeing BOMARC is U.S. Air Force's push-button defense weapon against airborne missiles and attacking bombers. New "B" models have scored test intercepts up to 446 miles from base at altitudes of more than 100,000 feet, establishing new surface-to-air defense missile records for range and altitude. BOMARC A models are now operational at five U.S. Air Defense Command bases. B models will be installed at six bases in the United States and two in Canada.

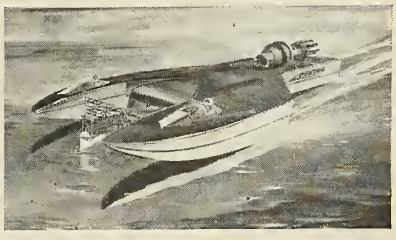
Capability has many faces at Boeing



WIND SONDE, developed by Boeing subsidiary, Allied Research Associates, will measure wind direction and velocity at wide range of altitudes, telemetering data back for instant use at missile launch ranges, other weather stations.



SPACEMAN'S BLAST-OFF. Boeing Space Medicine researcher prepares for simulated blast-off, wearing belt of Boeing-developed miniature electronic instruments which measure reactions to stresses imposed by take-off of space vehicles.



JET-PROPELLED TEST BOAT, now being built for Boeing, will be used to test experimental surface and subsurface marine vehicle designs at speeds up to 100 knots. Test models will be suspended between two forward hulls. Test boat will supplement Boeing tow-tank research in advancing knowledge in area of hydrodynamics.

BOEING

Unique Fleet of ASW Study Ships Urged

Design proposed by Douglas would center around steel sphere, have range of 100 n. mi., speed of 5 knots

by Richard van Osten

A FLEET of submarines with top speed of five knots has been proposed for ASW research by Douglas Aircraft Co.

The concept was outlined at the First National Innerspace Conference by Angus Jacks, ASW program supervisor, Douglas-El Segundo, and Rex E. McConnelly, design specialist.

A unique feature of the suggested design is that it would be built around a steel sphere like that of the Trieste vehicle. It also retains the gasoline-filled buoyancy hull constructed of welded aluminum. Large fairings of more or less conventional submarine shape, however, would streamline the sphere sufficiently to permit a mixmum speed of five knots with minimum electrical propulsive power.

Also as in the Trieste, two hoppers filled with iron shot are provided both fore and aft for use in adjusting buoyancy. The hull, steel-sphere cabin and other equipment mounted near the keel line are protected by sled-type runners which will support the craft both out of the water and on the ocean floor.

The bow area is fitted with an active sonar system for navigation and obstacle warning. Main hull hardback around the Fairwater is designed for an external store on either side to permit carrying a variety of test devices and equipment for R&D purposes.

Complete vehicle without crew and fuel would weigh 99,700 lbs. out of the water. The hull is 66.5 ft. long and 10 ft. in diameter. When the vehicle is resting on the runners, Fairwater top is 16 ft. high. Submerged displacement it 32.5 long tons and the design depth is 36,000 ft. Range is 100 nm at 5 knots.

The spherical cabin is designed for pressures of 8 tons per square inch with a safety factor of two. Compared with a cast steel sphere with a weight buoyancy ratio of 4:1, the welded steel unit has a weight buoyancy ratio of 2.5:1.

Buoyancy is a prime problem because a larger gasoline-filled hull is required for any excess weight carried. For this reason, other hull components, including sled runners, are aluminum.

Two-man crews may be required to operate the sub for periods of from 20 to 36 hours for certain missions. For crew comfort, the main cabin, or control room, in the sphere will not be crowded with equipment. Many items, electronic devices and equipment, can be packaged for free flooding or in pressure containers in other hull areas. Seating arrangement, controls and visual display in cabin follow a side-by-side, aircraft-type arrangement. Controls are arranged so either operator can take over full command. The cabin is air-conditioned, and a floor well permits operators to stand erect.

Closed-circuit TV will provide continuous viewing in one direction or selective viewing in several directions, depending upon the number of TV cameras installed. Sonar data are presented on a separate scope. Attitude and navigation data presentations are similar to current aircraft systems. The cabin is equipped also for direct view through an optical window. The view may be optically magnified and reflected to either operator.

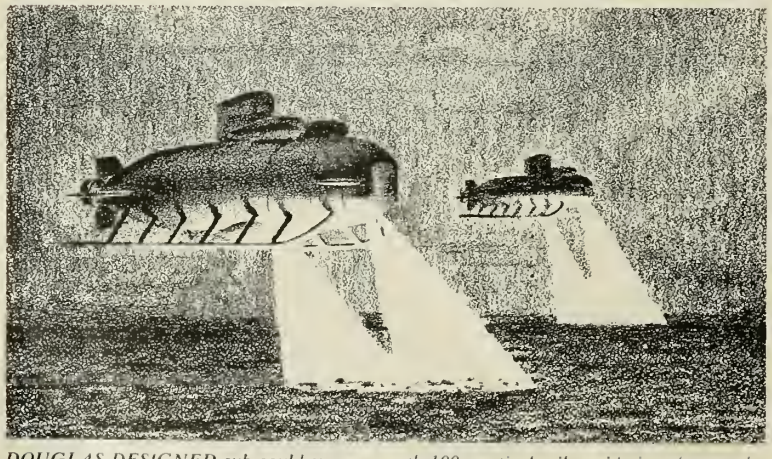
The air conditioning system is similar to those under development for space flight. Recent development of a thermoelectric junction—bismuth telluride—makes heating, cooling, and dehumidification possible in a simple unit. Addition of a potassium superoxide—KO_2—module for an oxygenator and a carbon dioxide makes a complete air conditioning unit. A unit for 2 men for 10 hours has a volume of 0.88 cubic ft. and weighs 32.5 lbs. The basic package requires one kilowatt of power. Duration can be extended by increasing size of the potassium superoxide—KO_2—module.

In addition, equipment cooling can be satisfied by increasing the number of thermoelectric packages. Cooling requirements can be reduced by hull installation of some units.

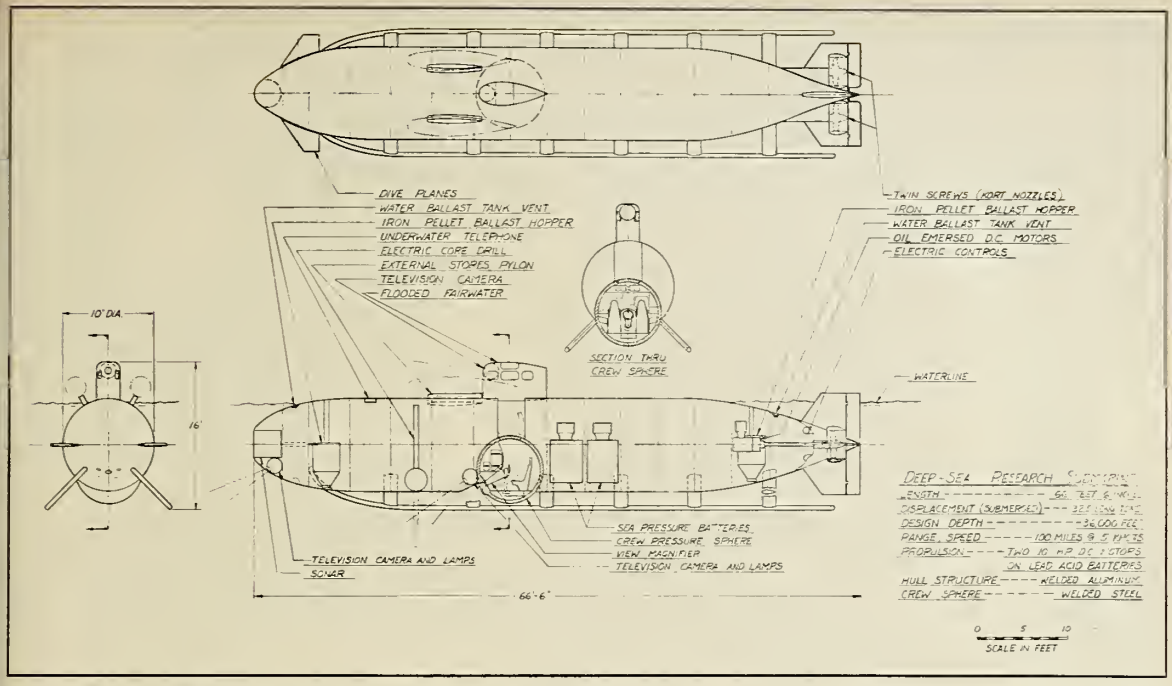
• **Propulsion system**—For reliability and flexibility, twin electric propulsion units are used. Each consists of an electric motor, gearbox, shaft, and propellor in a kort nozzle-type shroud. Units are counter-rotating.

The sub requires 17 shaft hp to attain five knots when submerged—requiring two motors of 10 hp each. The d-c motors are immersed in transformer oil and pressurized to a few pounds over sea pressure at all depths of operation.

Battery power of lead-acid type supplies primary propulsion power. Lead-acid batteries were chosen after careful comparison with silver-zinc types. The basic reason was primarily economic, despite some weight penalties resulting



DOUGLAS-DESIGNED sub could survey a path 100 nautical miles wide in a few weeks.



CONCEPT OF ASW research submarine has spherical cabin with room for two-man crews. Sphere will be free of most equipment.

from the choice and some increase in original submarine cost. The battery should be designed for operation under normal ambient sea pressures—cells can be pressurized much the same manner as described for the electric motors. The need for a heavy battery case can be eliminated by using an electrolyte reservoir connected to the cells through a stepped-pressure piston, to keep internal pressures slightly higher than sea water outside.

• **Operations**—A typical operation might include an ocean-bottom survey out to a radius of 50 nautical miles in several directions from a tender. Subs would be dispatched in pairs—the buddy team concept—to run parallel courses while maintaining communications with each other. The low-light-level cameras would be operated continuously. Temperature and salinity data could be recorded as required for research purposes. Bottom topography would be photographed.

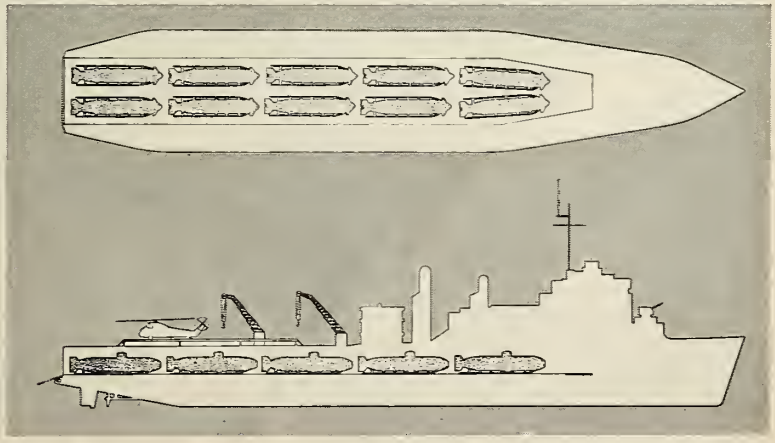
Each sub would be equipped with external stores, one of which could be an emergency message buoy which, if released, would rise to the surface and provide a marker while automatically transmitting an emergency message. Another type of store could collect samples of sea water and marine life. With the system, a survey path 100 n. mi. wide could be completed across the Atlantic in a few weeks.

Other uses for research subs could be planting and recovery of various types of deep-ocean devices for ASW work, search and salvage operations of a limited nature and ASW equipment in the development stage.

• **Support system**—Size and other dimensions of the research subs suggest adaption of a landing ship dock—LSD—as a tender. The tender could also be used to transport a small squadron of the deep ocean research vehicles to any point in the world's oceans. Except in very rough weather, the sub could be launched and recovered under its own power. Estimates show that 10 or more of the subs could be accommodated in the dock area of an LSD.

Other facilities of the LSD could be adapted at a minimum cost to handle the subs, including associated Navy and scientific personnel. Some minor LSD modifications would be required to service the special equipment, propulsion system components and electronic equipment to support the ocean research task force.

Douglas engineers say that if several groups of the vessels could be built, the cost becomes even more reasonable. In addition, individual ships can be fitted with different types of research equipment and crew experiences pooled for mutual benefit. Data from several simultaneous operations can be collected for the concentrated attention of a central analytical team. ⁂



TEN OR MORE of the subs could be accommodated on the dock area of an LSD. The tender could transport a fleet of the subs to any part of the world's oceans.

Microfilm TV May Cut Duplication

GPL development magnifies up to 1000 times, is easily controlled with lone stick; inspection will be aided

by Charles D. LaFond

DAYTON, OHIO—A Microfilm Televiser system which permits its operator to view any photograph remotely from central file with up to 1000 times magnification has been developed by General Precision, Inc.

The readout screen for the closed-circuit TV is manipulated by a seven-way switch and control stick. Magnification and image position can be changed at will throughout the entire range without loss of focus.

A prototype system was demonstrated for the first time at the National Aerospace Electronics Conference here recently. An improved version will be exhibited at the Armed Forces Communications and Electronics Association Conference June 6-8 in Washington, D.C.

The new system, according to inventor Warren Novak of the company's GPL Division in Pleasantville, N.Y., offers an opportunity to eliminate much of the duplication of files now common in industry today.

For example, if an engineer requires access to microfilmed data (on automatic data processing cards) in a central library, he can simply phone his request. The desired microfilm aperture card is inserted into a televiser and the image is transmitted to the engineer's monitor.

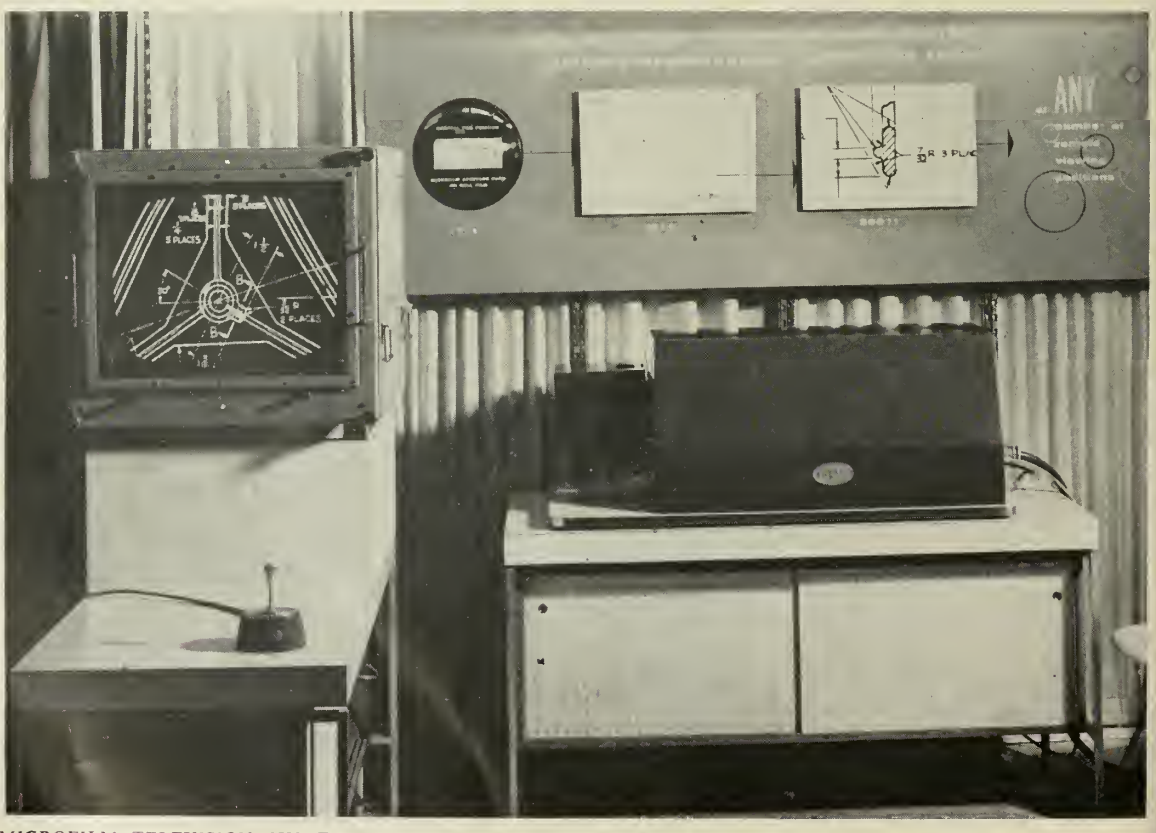
He then can move any part of the televised picture to the center position of his screen and readily magnify or blow up any portion that he chooses. A single aircraft-type stick control is used. A forward or backward movement of the stick raises or lowers the TV images; left or right movement is handled similarily. Magnification is controlled by twisting the stick; counter-clockwise for decrease, clockwise for increase.

The stick always returns to center and the switch holds at the position of the last manipulation.

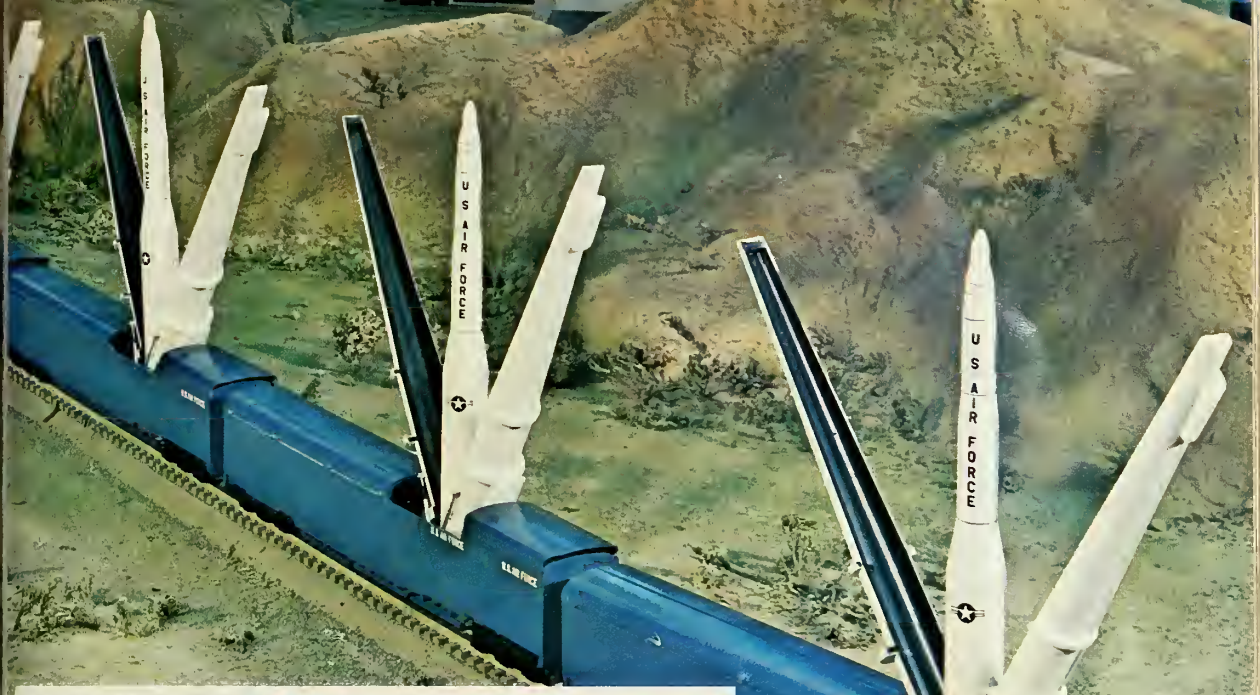
An operator can properly familiarize himself with the control stick in just a few minutes. A feature can be added, Novak said, which will permit the operator to change from a white-line to a black-line image.

The company, he said, also holds

(Continued on page 37)



MICROFILM TELEVISION SYSTEM demonstrated recently by GPL Div. of General Precision, Inc. Left front, control stick; left rear, high-resolution TV monitor displays portion of drawing; center, microfilm aperture card televiser.





STRATOFLEX ASSEMBLIES HELP READY THE MINUTEMAN FOR COMBAT

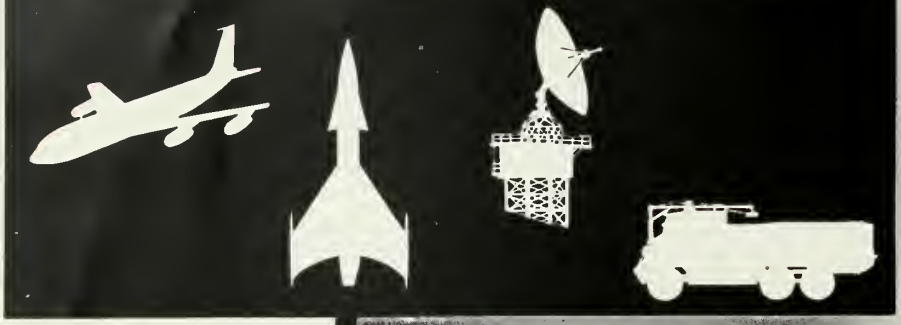
With "strong backs" open, the U. S. Air Force's Minuteman intercontinental ballistic missile is erect and ready for combat from its railroad launching site, as shown in the scale model photograph above. Stratoflex is proud that its hose assemblies and accessories are a vital part of the hydraulic system that provides the power to open and close the "strong back", the shell-like container that controls the environment and gives the Minuteman structural strength in transport. The Minuteman, assembled and tested by Boeing and scheduled for operational status by mid-1962, is one of several important missiles where Stratoflex hose and fittings are contributing to dependable performance. Stratoflex offers complete hose assemblies, hose and fittings in a wide range of sizes and types for most fluid applications, allowing engineers exceptional freedom in equipment design. For complete information, write for Stratoflex Aircraft & Missile Catalog today.

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(Continued from page 34)

engineering patents on prototype equipment for other auxiliary functions. These include:

—Automatic loading. Aperture film cards can be inserted automatically into the Microfilm Televiser.

—Automatic search, retrieval, and loading.

—Viewing of other objects. Special adapters have been devised to transmit images from opaque documents or micro components such as transistors, diodes and microminiature wafers.

Presently under development is a modified version of the machine which will permit the operator to observe a highly magnified image of tiny solid objects while manipulating their position with the control stick.

With this equipment, Novak said, components such as transistor and diode assemblies, instrument and watch parts, biological specimens, and living organisms can be examined. Inspection of microcomponents of any kind will be greatly aided by this new tool, he believes.

Since the TV image may be as large as 9 x 12 feet (using projection TV equipment), hundreds of people could view a picture or sequence of pictures simultaneously.

Conference connections are also possible, and these would permit a number of TV monitors to be located in different parts of a hospital, school or factory and to display images to all points at the same time. ⁂

Long-lived Tiros Doubles Original Life Expectancy

TIROS II, NASA's meteorological satellite, is still transmitting useful data —three months beyond its expected operational life.

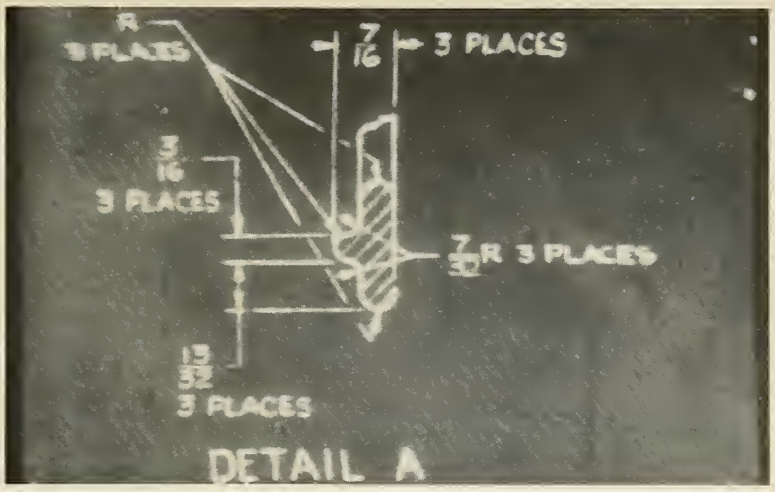
Television cameras are working as well as when first launched last Nov. 23. Infrared systems, however, are practically finished. Only one of the five systems is now operating—and this on a very limited basis.

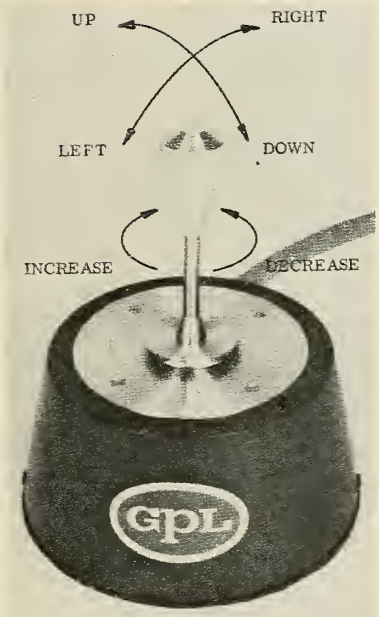
All electronics equipment in the RCA-built payload—including tape recorders—continues to operate.

Tiros' two television camera systems have transmitted a total of over 31,000 photographs. The bulk of these—76-78%—have been classified as fair-to-good for meteorological analysis.

Tiros III is scheduled for launch this summer. It is hoped that it will be operating during the hurricane season and will obtain TV pictures and infrared data on at least one of these destructive storms.

The entire *Tiros* program will likely be stepped up considerably if Congress approves President Kennedy's recent request for funding boosts. ⁂

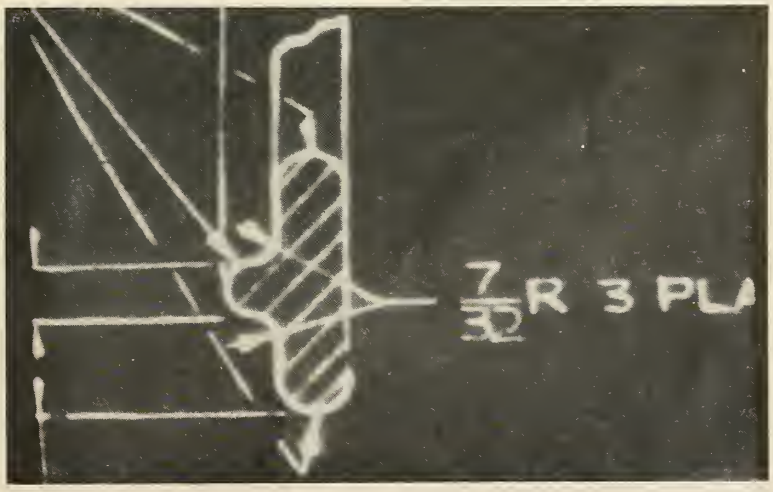




ABOVE: *Television image of a portion of an engineering drawing produced with the GPL Microfilm Televiser. Image is 1½ times greater than corresponding area on original drawing, and 50 times greater than the corresponding area on microfilm.*

LEFT: *Control stick for Microfilm Televiser, used at either local or remote positions, centers image and regulates its size.*

BELOW: *Central portion of same image shown in top photo here is three times greater than the corresponding area on original drawing and 100 times greater than corresponding area on microfilm. The range of enlargement is so great that a detail occupying 1/1000 of the area of the minimum-size TV picture can be made to fill the monitor's entire screen.*



Foreign Exhibits Top Paris Air Show

(Continued from page 18)

Sud Aviation disclosed at the show that on May 26 it successfully fired its single-stage *Bélier* research probe to a height of 60 mi. at Colomb-Béchar. This is one of two Sud rockets developed for an atmospheric research program for CNET, the French national telecommunications center.

The second, on display at the show, is a two-stage *Centaure* rocket which will reach a height of 240 mi. It is scheduled for its first firing this summer.

Societé Generale de Mécanique-Aviation-Traction (MATRA) displayed several air-to-air missiles, including the MATRA *R-530,* which is to replace the earlier *R-511.* This two-stage solid-propelled weapon has a range of 9-12 mi. and a speed of Mach 2.5-3. It is equipped with radar homing guidance. An advanced version with infrared guidance is under development. Both guidance systems permit omnidirectional attack.

Launch weight is 429 lbs.; length, 11.09 ft.; fuselage diameter, 0.85 ft. Wings are cruciform with a span of 3.6 ft.

French naval missiles on display included the Latecoere *Malafon* surface-to-underwater ASW weapon, and Ruelle surface-to-air *Masurca.*

C.T. 41 and *C.T. 20* target drones produced by Nord Aviation also were displayed. The *C.T. 41* is a supersonic twin-ramjet which employs two solid-propelled boosters for launch. Radio-controlled and recoverable, it is capable of Mach 2 cruise at 65,000 ft. for 14 min.

The *C.T. 20* is powered by a Marbore turbojet developing 880-lb. thrust. It is ramp-launched with two solid-propellant boosters developing 9920 lbs. thrust each.

Display by the Office National d'Etudes et de Récherches Aéronautique (ONERA), the French equivalent of the National Aeronautics and Space Administration, included the four-stage Mach 12 *Berenice* research missile, capable of reaching a height of 720 mi. with a 66-lb. payload. Also shown was the four-stage *Antares,* which can boost a 33-lb. payload to 216 mi.

ONERA's pavilion exhibit included a Mach 5 experimental ramjet missile.

• **From down under**—An Australian *Jindivik Mk. 2B* target drone was on display with a number of special trials aids including flare heat sources for simulating the jet efflux of larger aircraft, microwave reflectors and transponders for enhancing radar acquisition and jettisonable camera pods.

The *Mk. 2B* is powered by a single Bristol Siddeley Viper ASV.8 turbojet engine, providing the *Jindivik* with a 600-mph performance and an operational ceiling of over 50,000 ft.

Also shown was a new British Army launcher vehicle for the Australian *Malkara* antitank weapon. This is a self-contained armored fighting unit, which can be dropped into forward areas by parachute. It will carry four *Malkaras.*

The *Malkara,* a wire-guided missile, now is in quantity production in Australia, as the British Army's standard antitank guided weapon. It is 6 ft. 5 in. long and weighs 216 lbs. Propulsion unit is a two-stage, solid-fuel boost sustainer motor.

To some observers, engine developments at the show were of more significant interest than the missiles which were unveiled.

• **SEPR power**—Societé d'Etude de la Propulsion par Réaction (SEPR) displayed its SEPR 844 pump-fed rocket engine intended for the Mirage III E aircraft. Employing nitric acid and kerosene, this delivers a thrust of 3310 lbs. for 80 sec. A hypergolic mixture is used for ignition.

Specific consumption is given as .0048 lb./lb./sec. at sea level. Naked engine weight is 190 lbs. Weight of the whole rocket assembly, including engine, oxidizer tank structure, pressurization and accessories set at 496 lbs.

The engine makes a wide use of light alloy parts, limiting the use of stainless steel to the tank and to some parts of the oxidizer circuit. It is intended as a successor to the SEPR 841 engine.

The French Air Force has ordered 150 SEPR 841's for the Mirage III C. These are being mass-produced by Hispano-Suiza and will be followed in production by the SEPR 844.

SEPR reported that a complete engine change including checkout could be accomplished with the 844 in less than 25 min. Time for physical engine change only, excluding checkout, was given as 3 min. 50 sec.

Advanced studies by SEPR, which concerns itself solely with propulsion, include both liquid and solid engines. Work is progressing with liquid hydrogen, fluorine, and more conventional LOX and hydrazine. Monopropellants and hybrid engines also are under development.

In space propulsion, SEPR is looking at plasma jets, ion engines and other systems utilizing solar energy and atomic power. More emphasis is being placed on plasma jets than on ion sources.

While many of the firm's operations are highly classified, it was revealed they are developing filament winding techniques for motor cases and reinforced plastics for nozzles and other high-temperature areas.

The firm reported it has been highly successful with a super-dense graphite in nozzle throat applications. SEPR experts say the material seems to be superior to any being used in American solid motors. The graphite is manufactured by Carbon Lorraine.

• **British advances** — Filament wound cases and exit cones were exhibited by Bristol Aerojet Ltd. Under a two-year contract with the British government, the firm is about to initiate a program to study fatigue characteristics of glass cases, it was revealed.

Bristol Aerojet also has perfected a method of producing accurate thin walled cylinders by helically welding strip. The process has been successfully applied to the manufacture of rocket motor cases. Stainless steel, nimonic monel, titanium and xirconium have been welded in diameters up to 54 in.

Three rocket motors were displayed by Bristol Siddeley, including the Stentor which powers the Avro *Blue Steel* missile. The Stentor, in quantity production at Bristol Siddeley's Coventry factories, burns kerosene with hydrogen peroxide in high-pressure combustion chambers.

Also displayed was the liquid Gamma, propulsion unit for the *Black Knight* re-entry research vehicle. This is equipped with four trunnion-mounted combustion chambers which swivel under hydraulic actuator control to provide vehicle control.

Gamma, burning high-test peroxide and kerosene, produces a sea-level thrust of 16,400 lbs.

Also shown was the Thor BT-1 ramjet, which is fitted to an early version of the Bristol/Ferranti *Bloodhound.* Thrust was given as 5275 lbs. at Mach 2.

Electronic equipment on display included de Havilland's Automatic Checkout and Recording equipment (ACORN). The system originally was designed as GSE for the *Blue Streak* missile. ACORN controls pressurization, fueling, auto pilot and guidance. It monitors pressures, temperatures, flow, voltages, current and frequency. For launch, the system starts the engine and operates the release gear.

The checkout equipment performs either a single control action or sequential programed routines of control actions. Programing of the 300 available channels is subdivided into four main routines, 88 channels each, and on any one main routine eight subroutines may be programed—each subroutine consisting of an unbroken block of channels already programed in the main routine. The system weighs 1800 lbs.

Nord's AS-30

(Continued from page 18)

was able to reveal almost complete performance and design details.

"As a result, they're comparing apples with oranges," one Martin official asserted angrily in Paris, "stacking their latest model up against our early one."

Nord reports that mass production of the *AS-30* is scheduled to start at the end of this year. Under study is second-sourcing of the *AS-30* outside France if it goes into production for NATO. Nord also is planning to offer the missile to the U.S. as a competitor for *Bullpup*.

This could raise the same dispute in the Pentagon stirred up earlier by the Nord *SS-11* antitank missile purchased for the Army. General Electric is licensed by Nord to build the *SS-11* in the U.S.—as it did the *SS-10*. Army officials felt it was cheaper, however, to buy the *SS-11* directly from Nord, an anti-Buy American decision that was fought to highest levels in the Pentagon.

• **Costs argued**—Nord asserts that simplified tooling set up for the *AS-30* will bring its cost well below that of *Bullpup* in quantity production. Officials of the French concern admit that if the cost of the larger warhead is included the *AS-30* might have a higher initial cost than the *Bullpup A*.

Martin's position on this is that all *AS-30* cost figures are, in fact, paper figures since the missile is not in mass production. *Bullpup*, on the other hand, has been in production and operational with the Navy since April, 1959, and with the Air Force since November, 1960, it is pointed out.

Nord asserts that training costs can be considerably lower with the French missile due to Nord's development of a family of air-to-surface weapons, all employing the same guidance system—the *AS-11, AS-12, AS-20* and *AS-30*.

After initial ground training with an *SS-10*, a pilot could get his initial air-to-surface training in a light jet trainer with the *AS-11*, which has characteristics similar to those of the *AS-30*, Nord points out. The *AS-11* is ten times cheaper than *AS-30*, according to company sources.

He then could graduate to training on his own combat jet with the *AS-20* and finally *AS-30*. After checking out the *AS-30*, he could maintain his proficiency with the cheaper missiles.

Martin's answer to this is that the *Bullpup ASM-7A, GAM-83A, Bullpup B* and *GAM-83B* themselves form a formidable weapon family. In addition, a *TGAM-83* is well along in development for the Air Force. This is a cheaper, simpler training missile with the guidance characteristics of the *GAM-83*.

Nord has designed the *AS-30* for Mach 2 fighters, such as the Dassault Mirage III and the Lockheed F-104. Guidance equipment carried by the launch aircraft includes transmitter, missile control stick, coordinate changer, and power supply inverter. Also in the aircraft are fire control and ancillary circuits.

Missile launchers are fitted under the aircraft wing or fuselage with the missiles attaching at three points. To aid in observation after launch, a tracer flare is fitted at the rear of the missile.

• **Performance dispute**—Nord claims that the French Air Force laid down wider operational requirements for *AS-30* than the U.S. Navy did for *Bullpup*. Company officials point to greater weight, larger wing area and higher maneuverability. The *AS-30* can be fired up to 20 deg. from line-of-flight, it is claimed, while *Bullpup* cannot.

"This simply is not true," a Martin official asserts. The Air Force proportional controller for *GAM-83* is known to have an off-set capability greatly exceeding that of *AS-30*. Exact figure is classified but it is believed to approach 90 deg. after an initial straight-ahead launch.

Nord also claims that *AS-30* possesses an operational advantage in that a fighter can fire it horizontally from behind a hill and then fly it into the target, pulling away from the target area at distances as great as 2.5 mi. This, together with a greater range, means a fighter can operate more than a mile further away from the defense with *AS-30's* than it can with *Bullpups*, the French company asserts.

"Again, not true," is the Martin answer. Martin asserts that fusing in the *AS-30* warhead gives the French missile a longer minimum range and shorter maximum range. This smaller-range envelope, it is charged, means the *AS-30* cannot fly as long or hit as close in as *Bullpup*.

Martin spokesman point out that the *GAM-83B* possesses an additional advantage in that it is a nuclear weapon while Nord claims only that its *AS-30* has a nuclear capability.

Nord has not emphasized *AS-30's* capability in meeting environmental requirements on vibration, temperatures and fungus; Martin asserts *Bullpup* has fully qualified in this respect.

Both Nord and Martin claim high reliability for their weapons, with the Navy permitting Martin to say that *Bullpup* reliability is in excess of 90%.

Nord claims high accuracy for its new weapon. Navy reports show that *Bullpup* has surpassed its specification requirements on accuracy. ⌗

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Douglas Gears Up for Saturn S-I

by Frank G. McGuire

SACRAMENTO, CALIF.—Modification of two *Thor* test stands and installation of two 90,000-gallon liquid hydrogen tanks is well under way here in preparation for the *Saturn S-IV* vehicle test program, expected to begin late next year.

Douglas Aircraft Co., developer of the *S-IV* stage for NASA's Marshall Space Flight Center, estimates that the modification will cost $2 million.

S-IV, slated to use six 15,000-lb.-thrust liquid hydrogen/liquid oxygen engines, is currently in its engineering design stage at the Douglas Santa Monica plant. The Pratt & Whitney LR-115 engines will be run through a series of advanced engine tests on the stands before full vehicle static tests are conducted.

Douglas said all vehicles in the *S-IV* program will go through the Sacramento facility, whereas only selected *Thor* vehicles were sent here. Ten vehicles are involved so far, with possibility of follow-on orders likely. Six or seven months of "battleship" tests will precede production vehicle tests, in order to wring out propulsion systems.

Dwell time of each *S-IV* vehicle at the Sacramento facility will be about two months, company officials said. They declined to estimate when the first ten vehicles now committed would complete tests.

H. M. Thomas, Douglas *S-IV* Program Manager, said he does not expect that his firm's part of the program will be delayed by the difficulties being experienced with the propulsion system (M/R, May 15, p. 33). He said Douglas has been assured that troubles will be cleared up in sufficient time for his group to continue unaffected.

Testing at Sacramento will be done under Douglas manager J. F. Goodman, who also conducted all *Thor* tests at the site.

Stand #1 is a single-position unit to be used for the battleship tests (conducted with over-strength, non-flying hardware) and for acceptance tests with the flight-weight production vehicles.

Stand #2B is a two-position unit, one side of which will be used to house a prototype flight-weight vehicle (not one of the ten delivery models) for continuing tests as a laboratory to check all systems. This prototype unit will remain in stand #2B throughout the program, and modifications found desirable through tests on it will be introduced into the delivery vehicles.

Thomas told M/R the switch to six LR-115 engines instead of the original four LR-119 engines required modification of the battleship tankage at the site, but not of a magnitude to cause any delays.

Coolant water for the tests will be drawn from local sources and will not be reclaimed.

The entire facility has one blockhouse and one central control station to serve both test stands, with patchboards used to switch from one to the other.

During the latter part of 1962, Douglas expects to mount the first six *S-IV* engines in stand #1 for engine runs up to the 90,000-lb.-thrust level.

During static firings, a steam-evacuated altitude simulator will create operational altitudes of about 100,000 feet for engine ignition, the altitude attainable within 90 seconds from start. The steam will be generated by a 250 hp steam plant with accumulators; and ejectors & diffusers will create the simu-



TEST STAND #1 (foreground) and Stand #2B, during modification from Thor test program to Saturn S-IV program.

lest Program

lated altitude. Steam will be stored at 250 psi in tanks beside each stand.

The Douglas site at Sacramento totals 4000 acres and presently has about 250 personnel, which is expected to increase as the *S-IV* program gets rolling.

The liquid hydrogen tanks, each 35 feet in diameter, will hold 90,000 gallons each, with boil-off limited to approximately 0.13 of one percent per day. The tanks, believed to be the largest spherical liquid hydrogen tanks in the country, are constructed of a ⅞"-thick Kaiser aluminum internal sphere, with a 2½-foot air-evacuated space filled with 60,000 lbs. of expanded volcanic silicate between it and the external steel sphere. The volcanic silicate is expected to provide sufficient insulation for the 500-degree differential between the liquid hydrogen at −423°F and the ambient temperature of the Sacramento area.

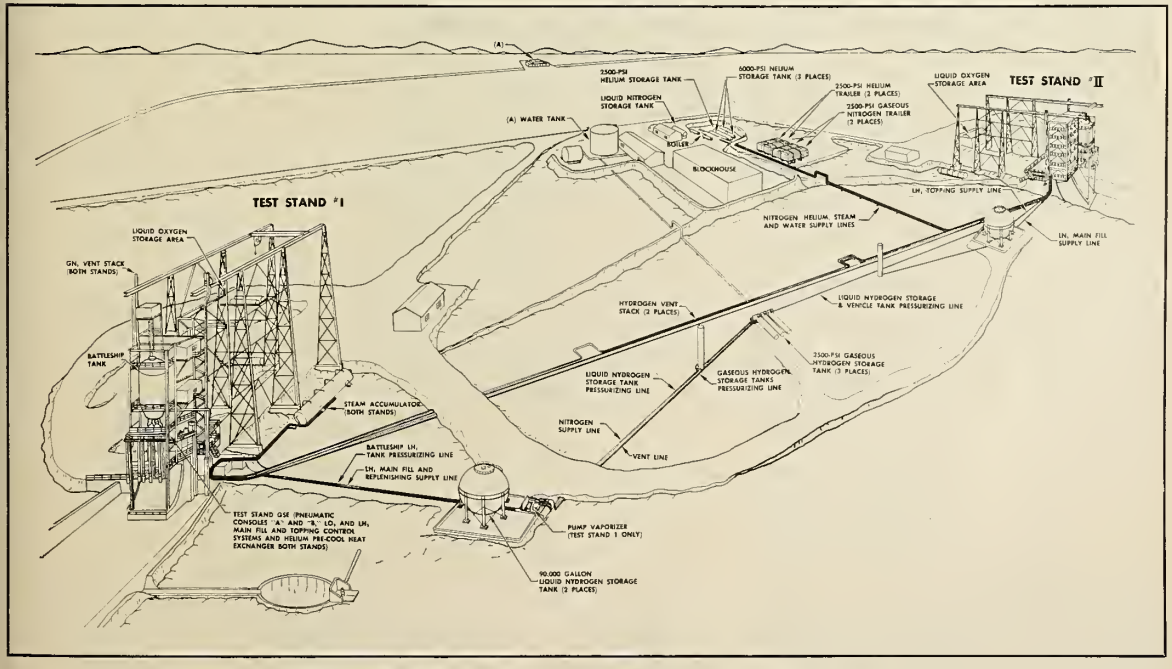
Segments of the tanks were welded on-site by the Chicago Bridge and Iron Co., then assembled by cranes. The 34,000-lb. internal sphere, resembling an aluminum space-age volleyball, was lowered into the 110,000-lb. outer tank and suspended on long rods designed to reduce heat transfer.



CHICAGO BRIDGE & IRON CO. crews assemble liquid hydrogen tanks for Saturn S-IV testing. Each of the 35-ft.-dia. tanks will hold 90,000 gallons of fuel.

Gaseous hydrogen will be used to pressurize the internal tank, Thomas said, to a level of about 80 psi, and the liquid hydrogen will be pumped through vacuum-jacketed transfer lines at the rate of 2000 gallons per minute. These lines are a four-inch stainless steel carrier pipe within a six-inch steel pipe, with boil-off reduced by a one-inch airless barrier between the two pipe surfaces.

Transportation for the *S-IV*, if a current Douglas proposal is carried through, involves securing the stage atop a C-133 for flying to launch sites. Wind tunnel tests indicate the plan is feasible, with minor modifications to the plane, including addition of vertical stabilizing surfaces at the tips of the horizontal stabilizers, and beefing up the load-bearing section of the fuselage. An alternate plan calls for 24-day shipment by barge. ❖



OVERALL VIEW of the Douglas-Sacramento Saturn S-IV test facility.

COMING UP!

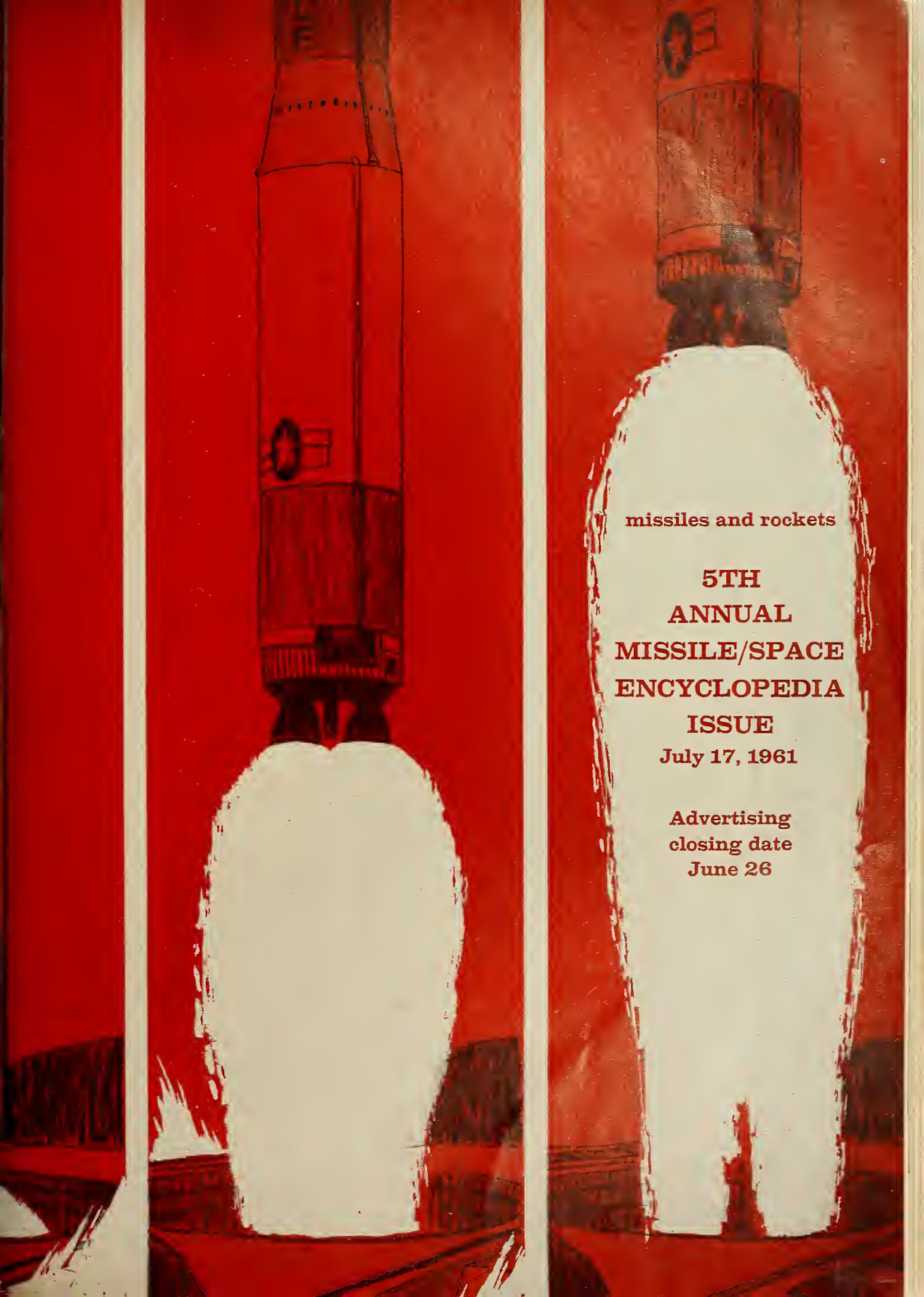
The only single source for a complete and comprehensive analysis of world missile/space systems, M/R's 1961 Missile/Space Encyclopedia will include diagrams and descriptions of all U. S. and foreign missiles and spacecraft.

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missiles and rockets

5TH ANNUAL MISSILE/SPACE ENCYCLOPEDIA ISSUE

July 17, 1961

Advertising closing date June 26

Shift in Space Plans

(Continued from page 14)

to develop flyable solid super-boosters range from 18 to 36 months. The cost of clustering them and developing the far more powerful lunar boosters has been estimated at more than $1 billion.

The Air Force will receive $15 million to develop the Martin *Titan II* as the first and second stages of a space booster. It was not immediately clear whether the *Titan II* would be modified to use the Lockheed *Agena B* or Convair *Centaur* as an upper stage; would be upgraded, or both.

The *Titan II* without modification is expected to be capable of boosting an 8000-lb. payload into a 300-mile orbit—only about 500 lbs. less than the *Atlas Centaur*.

The Kennedy revisions brought the NASA authorization request for FY '62 to a total of $1.8 billion—nearly $700 million more than requested by the Eisenhower Administration. The $77 million for the Defense Department brought the total authorization for military astronautics to about $850 million.

• **Half - loaf?** — The now - planned wide range of boosters is designed to give the United States a large and varied capability to operate both scientific and military equipment in space. But otherwise the Kennedy revisions left the Armed Forces without the means many military men feel they need now to defend the country in the Space Age.

Earlier this month Brig. Gen. Don Flickinger, Air Force bioastronautics expert, told a House committee: "I feel that we have fairly incontrovertible evidence that the Soviets have established quite a firm lead in manned space flight technology. As a military man in the life sciences area, I might say my greatest concern is their possible use of this superior technology to deny space to any of our vehicles either manned or unmanned in the relatively near future."

NASA Administrator James Webb told another House committee on May 15: "I think . . . our whole main effort is moving in the direction indicated by the concern of General Flickinger."

But regardless of these indications, Kennedy is still on record as saying the United States is now racing toward the moon in the name of science and national prestige. And most of the money that the Air Force has sought to develop military spacecraft has been refused.

The marching orders and map provided by the President for the U.S. drive into space appeared unclear at best. ⁂

NASA FY '62 Construction

	Eisenhower Budget (January)	First Kennedy Revise (March)	Second Kennedy Revise (May)
Langley Research Center	$ 3,980,000	$ 3,980,000	$ 3,980,000
Ames Research Center	6,380,000	5,680,000	5,680,000
Lewis Research Center	3,590,000	3,590,000	3,590,000
Goddard Space Flight Center	9,212,000	9,212,000	9,212,000
Wallops Station	6,313,000	6,313,000	6,313,000
Jet Propulsion Laboratory	3,642,000	3,642,000	3,642,000
Marshall Space Flight Center	8,891,000	12,891,000	12,891,000
Atlantic Missile Range	32,583,000	49,583,000	49,583,000
Pacific Missile Range	998,000	998,000	998,000
Various locations:			
Tracking facilities	16,811,000	15,761,000	20,761,000
Propulsion development facilities	1,175,000	1,175,000	31,175,000
Nova development and launch facilities	—	—	28,000,000
National nuclear rocket development facility	—	—	15,000,000
Manned space flight laboratory	—	—	60,000,000
Sounding rocket facilities	500,000	500,000	500,000
Damage repair and special construction	750,000	750,000	750,000
Advanced facility planning and design	5,000,000	5,000,000	10,000,000
Total appropriation requests	$ 99,825,000	$119,075,000	$262,075,000

NASA FY '62 Personnel

	EMPLOYEES			APPROPRIATION REQUESTS		
	Eisenhower Budget (January)	First Kennedy Revise (March)	Second Kennedy Revise (May)	Eisenhower Budget (January)	First Kennedy Revise (March)	Second Kennedy Revise (May)
NASA Headquarters	919	951	1,451	$ 13,032,000	$ 13,302,000	$ 19,339,000
Langley Center	3,220	3,330	3,628	31,451,000	32,197,000	34,702,000
Ames Center	1,437	1,437	1,570	16,134,000	16,134,000	17,290,000
Lewis Center	2,754	2,824	2,993	27,800,000	28,284,000	29,895,000
Flight Center	494	494	494	4,268,000	4,268,000	4,268,000
Goddard Center	1,798	1,828	2,028	25,124,000	25,424,000	27,237,000
Space Task Group	800	840	1,640	9,900,000	10,260,000	17,103,000
Wallops Station	299	299	399	3,118,000	3,118,000	3,808,000
Marshall Center	5,500	5,960	6,960	61,119,000	65,319,000	73,854,000
Western Office	65	85	85	917,000	1,107,000	1,107,000
AEC-NASA Nuclear Office	5	23	23	61,000	211,000	211,000
Life Sciences Station	51	51	151	476,000	476,000	1,286,000
Total	17,342	18,122	21,422	193,400,000	200,100,000	230,100,000
Less anticipated reimbursements				—3,414,000	—3,414,000	—3,414,000
Total appropriation requests				$189,986,000	$196,686,000	$226,686,000

Peaceful Benefits of Space Lauded

by John W. Herrick

TULSA, OKLA.—NASA and industry joined hands this last week to hail the expected multibillion-dollar boon to mankind from space exploration for peaceful purposes.

Some 1400 people attended the first National Conference on Peaceful Uses of Space at the Tulsa Fairground, a site apparently chosen by two prominent sons of Oklahoma, NASA Administrator James Webb and Chairman Robert S. Kerr of the Senate Space Committee.

Webb and Kerr set the tone of the two-day conference.

"All of the effects of the national space program will not be confined to outer space, itself," Webb said. "These effects will go beyond the impression they make in the minds of men around the world. You as a citizen, as a worker, as a parent, as a patient in a hospital, will feel them in your daily life."

Webb said that 3200 space-related products already have been developed in the United States.

Kerr warned that "the development of space programs is vitally important for national defense" and the nation "must never be unmindful of the tremendous military implications." But, he said, he saw "greater challenges to explore and utilize space for peaceful purposes.

"I am convinced that the nation which leads in exploring and using space for peaceful purposes can best build, improve and inherit the earth," Kerr said.

• **Satellite communications — too costly?**—Officials from RCA, General Telephone & Electronics Laboratories, Bell Telephone and other interested firms stressed the nation's urgent need for communications satellites. The only sour note in this area was struck by Edward R. Murrow, director of the U.S. Information Agency and former CBS vice president.

Murrow told the conferees that "over much of this globe there are unfed bodies that will turn to our satellite system with but marginal interest." And he added: "Maybe schools and sewers are more important than satellites."

In an uncut version of his speech Murrow also said: "In the field of communications satellites, I am told the Soviets have virtually defaulted. With only one horse in this race, we can be assured of a victory, regardless of our pace. But is it worth the cost? I do not mean to suggest an answer so much as to suggest that there are priorities to consider and assessments to weigh."

J. R. Pierce of Bell Telephone replied: "The ultimate cost (of transoceanic telephony by satellite) will be considerably less than providing such circuits by cable."

• **"No alternative"**—Among the most incisive addresses was one by Donald W. Douglas, Jr., president of Douglas Aircraft. He explored the great changes brought to industry by the missile and space age.

"During World War II, engineering and scientific employes made up only 3 percent of our total employment (at Douglas)," he said. "Five years later this force amounted to 10 percent of all employes. With the arrival of missiles, the number of engineers and scientists rose to 15 percent and, with the addition of space programs, now amounts to 20 percent. . . ."

Douglas predicted that in the next 10 years the proportion will grow to "one technical employe to every two shop and clerical employes."

Moreover, Douglas said the quality of the technical man and factory worker is steadily rising. He said "tomorrow the minimum standard for the majority of engineering jobs may well become a master's degree."

"The second Industrial Revolution has left us no alternative," he said. "We need men of knowledge, talent and creativity to spearhead our advance deeper into the Space Age." ⁂



Portrait of Mariner at Work

VENUS FLY-BY MARINER A—a 1000-lb. instrumented spacecraft slated to be launched next year by an Atlas-Centaur—is equipped in this Jet Propulsion Laboratory model with two solar panels, electronics package, high-grain earth antenna, radiometer antenna to measure plant temperatures, and magnetometer boom.

contracts

NASA

$6,000,000—**General Electric's Missile and Space Vehicle Dept.**, Philadelphia, for development of satellite control system to seek out stars for use in the Orbiting Astronomical Observatory. Subcontract from **Grumman Aircraft Engineering Corp.**

$248,000—**Atlantic Research Corp.**, Alexandria, Va., for 12 *Iris* rockets for carrying instrumented payloads between altitudes of 40 and 200 miles.

$185,000—**Collins Radio Co.**, Cedar Rapids, Iowa, for single sideband radio transceivers and fixed station equipment and accessories.

$112,636—**General Dynamics/Astronautics Div.**, San Diego, Calif.; $128,804, **Lockheed's Missiles and Space Div.**, Sunnyvale, Calif.; for systems studies to determine the potential performance of the *Saturn* booster using nuclear stages having various performance characteristics.

$106,000—**Wilmot Castle Co.**, subsidiary of **Ritter Co., Inc.**, Rochester, N.Y., for investigation of various methods of sterilizing missile components.

Cubic Corp., San Diego, Calif., for AGAVE tracking system, and participation in the *Samos* reconnaissance satellite program. Two contracts. No amount disclosed.

MISCELLANEOUS

$1,310,000—**American Electronics, Inc.**, Los Angeles, comprised of $760,000 from **Boeing Co.**, Seattle, for a static rotary power supply system for use at *Minuteman* underground launch sites; $326,000 from **Bendix Corp., Kansas City Div.**, for subminiature components; and $57,000 from **Raytheon Co., Aero/Weapons Div.**, Waltham, Mass., for special motors used in the *Hawk* and *Sparrow* missiles.

$1,000,000—**Federal Laboratories, Inc.**, Saltsburg, Pa., a subsidiary of **Breeze Corp.**, for the manufacture of tear gas.

$500,000—**HST Division, Dresser Electronics**, Garland, Tex., for engineering and production of special power supplies for traveling wave tube amplifiers.

NAVY

$58,659,000—**Bath Iron Works, Bath, Me.**, for construction of three guided-missile frigates. Vessels to have twin carrier/*Asroc* missile launchers and the DASH (drone antisubmarine helicopter) system.

$7,400,000—**Librascope Div., General Precision, Inc.**, Glendale, Calif., for production of torpedo fire-control systems.

$1,500,000—**Collins Radio Co.**, Cedar Rapids, Iowa, from BuWeps, for communication, navigation and identification systems (CNI); $640,679 for ground support equipment for CNI systems. (Two contracts.)

$1,001,108—**Texas Instruments, Inc.**, Dallas, for airborne radar systems for installation aboard carrier-based aircraft.

$723,000—**Emertron, Inc.**, Jersey City, N.J., from BuWeps, for reserch program in conjunction with development of new airborne electronic countermeasures systems.

$675,000—**Rocketdyne Div., North American Aviation, Inc.**, Canoga Park, Calif., from BuWeps, for development of advanced solid propulsion system for the *Sparrow* missile.

$670,000—**Bendix Corp.**, Ann Arbor, Mich., from BuShips, dispatch contract to begin work on expected $3-million program for development of shipboard communications terminal for use with the *Advent* satellite communications program.

Electro Nuclear Systems Corp., Minneapolis, for research in undersea acoustic measurements, data processing and analysis. No amount disclosed.

ARMY

$7,050,000—**Western Electric Co.**, for continued development work on *Nike-Zeus* missile system. Work to be done by **Bell Telephone Laboratories**, Whippany, N.J.

$355,000—**Hallicrafters Co.**, Chicago, from Signal Supply Agency, for development of airborne target simulator system to test radar equipment portions of *Nike-Zeus* missile system.

The Garrett Corp.'s AiResearch Mfg. Co., Los Angeles, from Picatinny Arsenal, for development of miniature turbogenerator designed for one-shot missile applications. No amount disclosed.

AIR FORCE

$13,000,000—**General Electric's Missile and Space Vehicle Dept.**, for servicing and installing equipment in re-entry vehicles at nine *Atlas* ICBM bases.

$3,000,000—**Baird-Atomic, Inc.**, Cambridge, Mass., from **Lockheed's Missiles and Space Div.**, for infrared detection systems for *Midas* satellite.

$1,250,000—**Electronic Communications, Inc.**, St. Petersburg, Fla., for new airborne UHF Multiplex Communications system.

$410,000—**Cessna Aircraft Co.**, Wichita, Kan., from **Boeing Co.**, for additional transporter-erector containers for the *Minuteman* missile.

$113,000—**Datex Corp.**, Monrovia, Calif., from **North American Aviation, Inc.**, for design and manufacture of five digital control systems to be used as training aids on *Hound Dog* missiles.

$50,000—**United Control Corp.**, Bellevue, Wash., from **North American Aviation**, for launch zones computing systems for operation with *Sidewinder* missile.

$50,000—**RIAS, The Martin Co.'s research division**, from OSR, for study of electron currents in crystals.

The Garrett Corp., Los Angeles, from **Boeing Co.**, for development of hydrogen cooling system for *Dyna-Soar*. No amount disclosed.

REQUESTS

The NASA Procurement Office, Marshall Space Flight Center, Huntsville, Ala., has issued a Request for Proposal No. TP 84044, for the development of a payload capsule for electrical propulsion system flight testing.

In the performance of this program, the contractor will design, fabricate, and test the capsules which will be used to test the engines. A total of seven capsules, three for ground testing and four for actual flight tests, will be furnished. Complete launch support will be provided by the contractor also.

Proposals are due to be received at the Office of Procurement and Contracts, Marshall Space Flight Center, NASA, Huntsville, Ala., by June 24, 1961.

The following firms have been invited to participate: Lockheed Aircraft Corp., Sunnyvale, Calif.; Northrop Aircraft Corp., c/o J. R. Bruce, 3322 Memorial Parkway, S.W., Huntsville, Ala.; United Aircraft Corp., East Hartford, Conn.; General Electric Co., Missiles and Space Div., c/o J. E. Harrell, Jr., 112 Gallatin St., Huntsville, Ala.; Space Technology Laboratories, Inc., Canoga Park, Calif.; Bendix Corp., Ann Arbor, Mich.; Aerojet-General Corp., Holiday Office Center, Huntsville, Ala.; Hughes Research Laboratories, Hughes Aircraft Co., 2806 Memorial Parkway, S.W., Huntsville, Ala.; Chance Vought Corp., Dallas 22, Tex.; Kelsey-Hayes Co., Detroit 32, Mich.; Ryan Aeronautical Co., 302 Electric Service Center, Huntsville, Ala.; Avco Corp., Wilmington, Mass.; United Systems Corp., Washington, D. C., Aeronutronics Div., Ford Motor Co., 3312 Memorial Parkway, S.W., Huntsville, Ala.; Convair Div., General Dynamics Corp., San Diego, namics Corp., San Diego, Calif.; Electro-Calif.; General Atomic Div., General Dynamics Corp., San Diego, Calif.; Electro-Optical Systems, Inc., Pasadena, Calif.; Douglas Aircraft Co., Santa Monica, Calif.; Plasmadyne Corp., 3839 So. Main St., Santa Ana, Calif.; Radio Corp. of America, Princeton, N. J.; Rocketdyne, Canoga Park, Calif.; Tapco Group, Thompson Ramo Wooldridge, Inc., Cleveland 4, Ohio; North American Aviation, Los Angeles 45, Calif., Att: L. L. Waite, Vice Pres.—Goodrich-High Voltage Astronautics, Inc., Burlington, Mass.

NASA suggests that small business firms or others interested in subcontracting opportunities on this procurement make direct contact with the above firms.

letters

(Continued from page 7)

new mare such as the Mare Imbrium. Some near-surface voids may have collapsed, forming certain of the craters which dot these seas.

If this simple-minded picture is reasonably correct, then a considerable volume of the Moon's outer structure consists of voids in the form of bubbles. These shrinkage voids would undoubtedly trap volcanic-type gases. As time passed, these gases would cool and the steam condense out as water. As a consequence, the Moon would be honeycombed to considerable depth with small-to-vast pressurized pockets of water, CO, CO_2, SO_2, N_2 and trace elements and compounds. By drilling, such reservoirs could be tapped for gas and water.

It is entirely possible that the Moon may contain, percentagewise, as much gas and water trapped in its outer skin as the Earth has in its hydrosphere and atmosphere.

Should this picture be even partially true, the Moon's ultimate potential cannot be overestimated. It would be necessary to think in terms of a three- rather than a two-dimensional geography. Ultimately, through the exploitation of these voids, the effective shirt-sleeve usable area of the Moon might approach that of an Earth continent.

All of this is strictly speculative. However, if it were even partially true, the implications for tomorrow's society would be enormous. Should the Communists exploit such a potential the consequences would be overwhelming.

Our lack of urgency in this area of exploration could possibly cost us dearly in the coming years.

Edward H. Dingman
Littleton, Colo.

Pluto Calculation

To the Editor:

In M/R, April 24, p. 15, under the heading, "Fallout of the ANP Program," you state that the heat transfer calculational techniques developed in this program are now being used in the Pluto program. This is not correct. The calculational techniques we use were developed here in their entirety, starting nearly two years before we were even engaged in the Pluto program. In addition, the functional form of the correlation used for local heat transfer coefficients is based solely upon early theoretical and experimental work carried out at NACA. The normalization constant now used was first derived by GE-ANP personnel from unpublished NACA data, since only they were in possession of the data at that time. Finally, the experimental verification of our calculations under the most extreme flow conditions was carried out here.

Robert H. Fox
Assistant Division Leader
for Advanced Reactor Research
Lawrence Radiation Laboratory
Livermore, Calif.



Ultra-Precision Tooling Balls

The Emmco Development Corp. has available a line of ultra-precision Tooling Balls welded by the Fridg-Flash process which have accuracies up to 50 millionths T.I.R. concentricity of ball to shank, 10 millionths ball roundness, ±20 millionths ball diameter, and 1 to 2 micro-inch ball finish.

Ball and shaft are minimum 45 Rockwell C, and built-in insurance against accidental use of bent or inaccurate tooling balls is incorporated into the two-piece construction.

Circle No. 225 on Subscriber Service Card

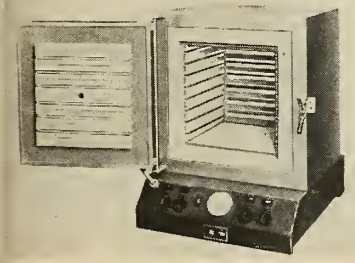
Semiconductor Bases

Ready-to-weld copper semiconductor bases, with integral steel rings already brazed in place, are available in the full-hard condition from Standard Pressed Steel Co. The base material is a hardenable copper alloy which possesses electrical and thermal conductivity properties comparable to those of oxygen-free copper.

Circle No. 226 on Subscriber Service Card

Hi-Temp Furnace

A small, compact furnace which heats up to 2000°F in one hour, 2300°F in one and a half hours, is available from L & L Mfg. Co. A constant level of temperature — ranging from 300°F to 2300°F—can be maintained by means of input controllers. These can be set at from 7% to 100% of input. Zone gradient control operates by multiple circuits, with each circuit having its own input controller.



Circle No. 227 on Subscriber Service Card

Mag-Clutch Combination

A size 11 magnetic clutch and spring centering mechanism coupled to a center-tapped potentiometer is available from Orbit Instrument Corp. Clutch energization engages the potentiometer for continuous rotation in either direction. Clutch disengages on de-energization and the spring centering mechanism returns potentiometer shaft to +15 mins. of pot centertapped position. Return time is under 1/2 sec. and fater returns can be obtained. Operating life is 1000 hours.

Circle No. 228 on Subscriber Service Card

Plastic Wiring Duct

An open-slot plastic wiring duct, available in an extended range of 25 different sizes, is being marketed by Panduit Corp. Designated Type E Panduct, the design incorporates rounded top surfaces on the duct. This protects wire insulation.

Circle No. 229 on Subscriber Service Card

Porosimeter

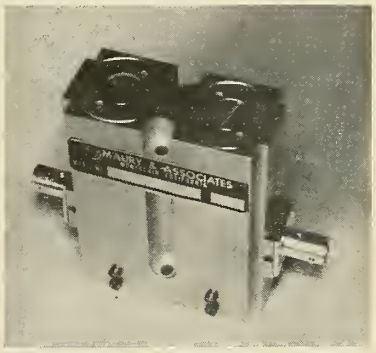
Quick, easy and accurate pore structure evaluations are readily obtainable using a porosimeter available from American Instrument Co.

Two Porosimeter models are available; one rated at 5,000 psi and pore diameter size to 0.035 microns, the other rated at 15,000 psi and pore diameter size to 0.012 microns.

Circle No. 230 on Subscriber Service Card

Band Pass Filters

Maury & Associates are marketing a series of miniaturized, tunable and extremely rugged band pass filters. The filters were designed for missile-borne applications and can withstand severe shock and vibration. They are manufactured to exacting standards from aluminum and rhodium-flashed over silver plate. They are negligibly affected by temperature or humidity changes. The filters have integral mounting features and are supplied with a locking tool for positive locking. Tuning is accomplished by a simple screwdriver adjustment. The filters are available at any center frequency from 100 to 4000 mc in dual or triple section units, and are supplied with either Type BNC, TNC, N or C connectors.



Circle No. 231 on Subscriber Service Card

Linear Potentiometer

The New England Instrument Co. has available a linear motion potentiometer with a stroke of 12 in. The unit has a wire-wound element with high resolution and a standard linearity of 0.05%—closer linearity can be supplied on special order.

Circle No. 232 on Subscriber Service Card

Environmental Thermostats

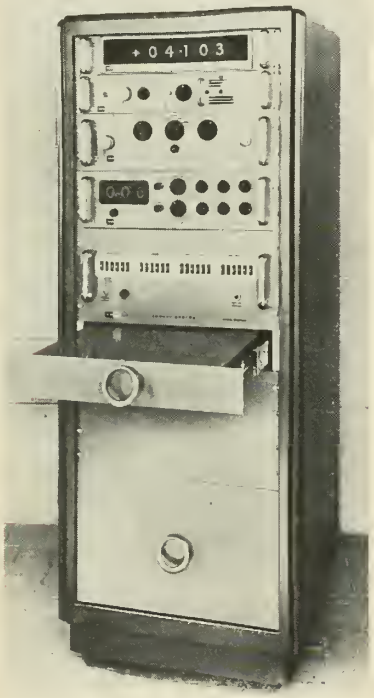
A group of special thermostats for use whenever moisture, fumes or dust are a problem is available from Stevens Manufacturing Co., Inc. Type GP

thermostats, listed in UL File SA 1761, are rated for 100,000 cycles up to a maximum operating temperature of 176°F. Actual electrical ratings vary according to operating conditions and other factors. At 120 VAC, ratings are 15 amps resistive, 5.2 amps FLA and 31.2 amps LRA.

Circle No. 233 on Subscriber Service Card

Digital System

Kin Tel Division of Cohu Electronics, Inc. is producing a multichannel, digital system which displays and records multiple low-level data signals. The system, Model ER-3295, accepts minute voltages from a number



of strain gages and thermocouples, amplifies and measures them, indicates the measured values numerically and records the measurements.

The finished record is a perforated tape which can be run through a computer or a combined tape reader and electric typewriter.

Circle No. 234 on Subscriber Service Card

Silicon Power Varactors

A series of 55 silicon power varactors housed in a hermetically sealed, reversible cartridge for applications in the 1 mc to 10,000 mc region are available from Microwave Associates, Inc. The types are considerably more efficient than previous types offered for harmonic generation applications and will handle substantially higher power.

Circle No. 235 on Subscriber Service Card

Airless Spray Coating

A Tygon® Protective Coating—The Tygon AV Series—designed for use with airless spray equipment is available from the Coatings & Linings Division of the U. S. Stoneware Co.

Possessing the same basic cororsion-resistant properties of conventional Tygon top-coat, the AV series can be used over any standard Tygon primer. In airless spray applications continuous passes can be used to build virtually any desired mil thickness in one coat without sags.

Circle No. 236 on Subscriber Service Card

Bench Altitude Chamber

A custom-built altitude and temperature test chamber, with refrigeration and compressor units on top of the chamber to permit the unit to be mounted on a work bench, has been produced by Aerotest Laboratories, Inc. The unit will reach an altitude of 90,000 ft. with a rate of climb of 5000 ft./min. Temperature drops to 100°F in 55 minutes, and rises to +250°F in 30 minutes.

Circle No. 237 on Subscriber Service Card

Temperature-Humidity Box

Hudson Bay Co., division of Labline, Inc., is marketing a 4-ft.^{3} upright temperature-humidity test cabinet. The unit has a temperature range of 0° to 200°F with a control tolerance of ±2°F and a humidity range of 20% to 95% RH within ±5%.

Circle No. 238 on Subscriber Service Card

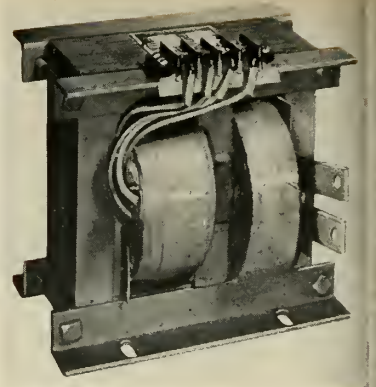
D-C Relay Tester

A DC Relay Tester Model 700 for adjusting and checking all types of d-c relays, magnets, small motors or other magnetic devices is available from Bliss Electronic Corp. The test set is self-powered and electrically isolated so that it may be connected to wired unit without removing them from the circuits.

Circle No. 239 on Subscriber Service Card

Saturable Core Reactor

A saturable core reactor wound with virtually no air gaps, which results in an extremely low magnetizing current and an unusually low noise output is available from Northelfer Winding Laboratories, Inc. The range of the 15 KVA, 1 ϕ saturable core reactor is



approximately 2% to 98%, depending upon the resistive load. Northelfer saturable core reactors are manufactured in ranges from 1 to 500 KVA in 1, 2 or 3 ϕ.

Circle No. 240 on Subscriber Service Card

Commutating Switch

Airflyte Electronics Co. is marketing a sub-miniature rotary commutating switch. Housed in a size #5 can, the commutator weighs less than 1.28 cc. Commutating surfaces are 18-karat gold, and brushes are multiple-strand, precious-metal, spring-temper, small-diameter round wire with current-carrying capacities to 250 milliamperes.

Circle No. 241 on Subscriber Service Card

Capacitance Calculator

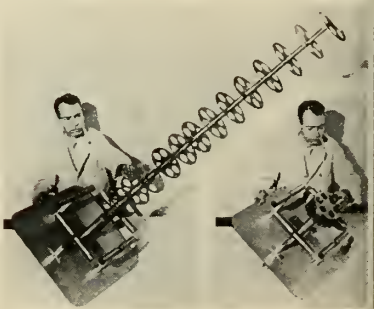
An easy-to-use capacitance calculator is available from General Electric's Wire and Cable Department. Designed in the form of a nomograph, it allows the user to estimate electronic cable capacitance or conductor size and/or insulation wall thickness to meet capacitance requirements without using algebraic equations.

Circle No. 242 on Subscriber Service Card

Collapsible Antennas

The first unit, Model #521A, in a line of modular construction collapsible antennas, designed for a variety of quick erection functions in the 350 to 600 megacycle frequency range, is available from Avien, Inc.

The antenna is a four-element array.



measures 6 x 6 x 7 ft. in operation, nd collapes to 4 ft. x 4 ft. x 20 in. The -521A can be further broken down for orage, and is transportable. Including anual pedestal, the array weighs only 5 lbs.

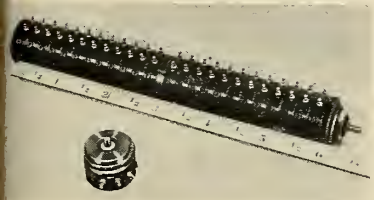
Circle No. 243 on Subscriber Service Card

Ganged Potentiometer

As many as 24 precision rotary potentiometers can be ganged on a single haft in a length of only 6 inches in he Series 319 potentiometer from Daystrom, Inc.

Installation time and cost can be aved in matching, balancing, and adusting variables in all other types of recision control, computing, and telemetering circuit networks.

Series 319 rotary potentiometers can e ordered with potentiometers already



ganged. The special wiper technique permits rapid phasing of individual potentiometers after installation, using a simple adjusting tool.

Circle No. 244 on Subscriber Service Card

Glass Zener Diodes

Subminiature glass zener diodes with an extremely wide voltage range (3.3 o 30 volts) and rated at 250 milliwatts power dissipation are available from International Rectifier Corp. Designated types QZ3.3T10 through QZ30T5, units are available in both 5% or 10% voltage tolerance types, and have a max. zener impedance range from 5 to 70 ohms. The devices are process-selected to provide exceptionally sharp zener characteristics.

Circle No. 245 on Subscriber Service Card

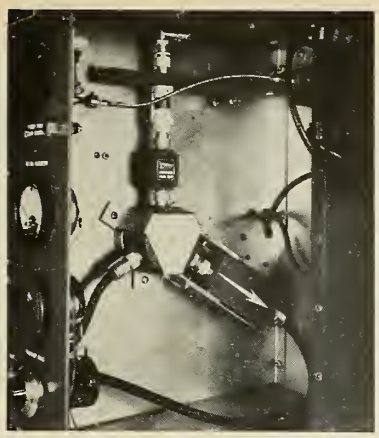
Fast Curing Epoxy

Allaco Produces is marketing a rapid-curing formulated epoxy adhesive. MINIT-CURE will cure in 60 seconds at room temperature and can be accelerated to 45 seconds with use of infrared heat. Possible applications include bonding metal to metal, plastic to metal, plastic to plastic or any other porous or non-porous surfaces.

Circle No. 246 on Subscriber Service Card

Parametric Amplifier

A low-noise L-band diode parametric amplifier for installation in AN/TPS-1D, AN/TPS-1G and AN/FPS-36 radar systems has been developed by Melabs. The parametric amplifier sets the system noise figure at 2 db or better. This represents a 7 db increase in sensitivity and is equivalent to a 50% increase in range for a given target or a five-fold decrease in minimum target size at a given range. The unit has an instantaneous bandwidth of 10 mc or more, which is tunable from 1200 to 1400 mc.



Circle No. 247 on Subscriber Service Card

Audio Multicoupler

A completely transistorized audio multicoupler with throwaway modules is available from Orthonix, Inc. The multicoupler is designed for use in the audio frequency range of 25 cps to 25,000 cps. It has unity gain and harmonic distortion of less than 2% at lv. out. The power supply consists of a transformer-coupled bridge rectifier designed to supply 12v. at 450 ma for the transistor circuits and the 10w. Zener regulator.

Circle No. 248 on Subscriber Service Card

Synchro Sector Switch

Mounted on the end of a size 8 synchro, a sector switch which provides a closed circuit whenever the position of the synchro exceeds ±70° from EZ is available from Clifton Precision Products Co., Inc. Versatility of this design permits the switch angle to be selected for the application. Adding only 0.500 inches in the overall synchro length, this unit finds applications wherever switching is required in conjunction with synchro angular positions.



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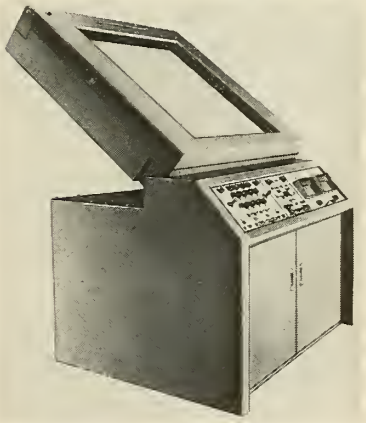
Multiturn Limit Stop

A miniature, servo-mounted limit stop, continuously variable from 0-42 turns, is available from the Reeves Instrument Corp. An external adjustment control permits the stop range to be varied without the need for disassembling the unit or removing it from its mount. The SR 3341 Limit Stop has a torque rating of 40 ounce-inches, with a maximum starting torque of 0.04 ounce-inches.

Circle No. 250 on Subscriber Service Card

Plotting Board

A vertical/horizontal plotting board which provides two simultaneous plots of any four independent voltages against time and is capable of tilting to a horizontal or vertical position has been designed by Milgo Electronic Corp. Designated Model #1587, the unit is designed to operate with analog and digital computers, coordinate converters, radars and other analog devices. Tilting of the plotting surface is accomplished electrically and can be activated during a plotting operation. Changes in the angular position of the plotting surface do not affect plotting performance.



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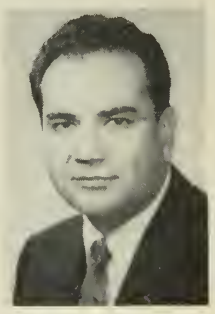
X Band CW Receiver

AEL, Inc. has developed a small, self-contained (battery-operated) X Band CW Crystal video receiver which employs video chopping. This receiver, the Model R115, is designed for direct connection to an antenna; by means of its built-in AEL Waveguide crystal mount, video chopper and chopper driver and video amplifier, it provides a d-c output proportional to the X Band signal input.

Circle No. 252 on Subscriber Service Card


GILSON


LOVENSTEIN


CANDELARIA


R. J. BROWN


HAIDUCK

S. W. Burriss: Named assistant general manager, *Polaris* missile system, and **D. J. Gribbon** assistant general manager, satellite systems—in Lockheed Missiles and Space Division, Sunnyvale, Calif. **C. A. Foter, Jr.,** promoted to administrative head of satellite programs at Lockheed's Van Nuys plant.

George F. Emerich: Former assistant to the vice president, appointed manager of Rocketdyne's Solid Propulsion Operations, McGregor, Tex.

Robert J. Gilson: Former director of systems management, named general manager of the Military Products Division, General Dynamics/Electronics, Rochester, N.Y.

George C. Tweed, Jr., and **Charles F. McCabe:** Appointed chief electronic engineer and chief electrical engineer, respectively, at Convair (Astronautics) Division of General Dynamics Corp., San Diego.

Capt. Sheldon W. Brown, USN (Ret.): Former assistant manager, named manager of Aerojet-General Corporation's Atlantic Division, Frederick, Md.

Dr. R. A. Gudmundsen: Named director; **Dr. Harvey Winston** associate director; and **F. G. Franciscus** administrative manager of the newly-formed Quantum Electronics Laboratories of Quantatron, Inc., Santa Monica, Calif.

Dr. Mervin J. Kelly, Dr. Charles C. Lauritsen, Dr. Roger R. D. Revelle, Dr. Otto H. Schmitt, and **Dr. William R. Sears:** Appointed members of the Douglas Scientific Directorate established recently to assist Douglas Aircraft Co. in planning the basic and applied research programs of its space, missiles and aircraft systems of the future.

Allen J. Lovenstein: Former manager of market development and analysis, appointed manager of the *Advent* satellite communications program at the Waltham Laboratories of Sylvania Electronic Systems, a division of Sylvania Electric Products, Inc.

M. M. Blair and **M. J. Sargeant:** Appointed manager of development planning in the Advanced Programs Development Department and chief of surveillance, Command and Control Systems Research, respectively, for North American Aviation's Space and Information Systems Division, Downey, Calif.

Laurence M. Silva: Named chief engineer of Electrosolids Corp., Los Angeles. Prior to joining Electrosolids, Silva was manager of the technical staff on research and development at Beckman Systems.

Dr. James B. Rea: Appointed vice president and assistant general manager, technical, for Radioplane Division, Northrop Corp., Van Nuys, Calif. Formerly Dr. Rea was manager of inertia guidance systems and space, ballistic missile systems and advanced program development at Hughes Aircraft Co.

Harvey A. Frank: Joins Electro-Optical Systems, Inc., Pasadena, Calif., as a senior research chemist in the Advanced Power Systems Division. **Armand R. Tanguay** and **Robert H. Dimond** appointed scientists in the Advanced Electronics and Information Systems Division.

Richard A. Campbell: Executive vice president of Pacific Semiconductors, Inc., and **Dr. Ralph P. Johnson,** vice president of Thompson Ramo Wooldridge, Inc., Electronics Group, elected members of the PSI Board of Directors. PSI is a subsidiary of Thompson Ramo Wooldridge.

Joseph Kelley, Jr.: Former executive vice president, appointed president and general manager of Allied Research Associates, Inc., Boston, Mass. Kelley succeeds **Lawrence Levy,** who has accepted a government post.

Richard Candelaria: Named president and director of American Orbitronics Corp., Washington, D.C.; **Joseph G. Rosales** named vice president for production at Hawthorne, Calif., factory.

David G. Ott: Former senior nuclear engineer, appointed manager of Applied Science Division, Internuclear Co., Clayton, Mo., a subsidiary of Petrolite Corp.

Dr. James Marsh: Former president of Electronics Specialty Co., named manager of the Sensors Department of Aerospace Corp., El Segundo, Calif.

Robert J. Brown: Former manager of marketing, named general manager of Heavy Military Electronics Department, General Electric Co., Syracuse, N.Y., succeeding **John J. Farrell,** who will be consultant to the vice president and general manager of the Defense Electronics Division.

Carl R. Wetterau: Joins Greer Hydraulics, Inc., Los Angeles, as assistant chief engineer. Formerly Wetterau was president of Flight Support, Inc., Metuchen, N.J.

Capt. Henry G. Munson, USN (Ret.) Joins the technical staff of Radio Corporation of America's Advanced Military Systems, Defense Electronic Products, Princeton, N.J. Munson's previous duty assignments included senior submarine member of the Navy Board of Inspection and Survey conducting the acceptance trials and inspections of nuclear propulsion submarines, and systems director for Nuclear Weapon Development in the Bureau of Ordnance which developed the *Astor* and *Asroc* weapons.

Andrew F. Haiduck: Former vice president of manufacturing, appointed vice president and general manager of Lear, Inc.'s Astronics Division, Santa Monica, Calif. Prior to joining Lear, Inc., Haiduck served as general manager and director of the Experimental Guided Missile Division of Fairchild Airplane and Engine Co. **James P. Brown,** former vice president and general manager of Lear's Astronics Division, appointed vice president and corporate director of marketing.

Charles C. Kelber: Senior staff engineer in Northrop Corp.'s development planning office, named supervisor of military space systems at the company's Norair Division, Hawthorne, Calif.

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Germans Eye Seacat

(Continued from page 19)

divisions in East Germany and that the Soviets can call 125 reserve divisions into service within 30 days.

The limited war problem was expressed by West German General Erich Hampe in *Wehr und Wirtschaft*—"But because the 'sword and shield' NATO concept is based on nuclear counterforce, the NATO Command faces the dilemma of being the first to use the means of massive destruction, execrated by world opinion, or of conducting a (defensive) war more than doubtful with insufficient classical weapons."

Classical weapons here include nonnuclear rocket vehicles or any nonnuclear missile system proficient enough to accurately neutralize tactical or strategic targets.

Dr. Adenauer and Defense Minister Strauss have consistently supported the U.S. policy of building a strong strategic nuclear deterrent to prevent attrition of NATO forces by the Communists as well as to daunt any all-out surprise nuclear attack on any NATO member.

They are augmenting "classical" missile striking power on land and in the Baltic, where the "Ostseeflotten" of East Germany, Poland and Russia is active and where Communist naval power is linked to the "sleeping" Soviet Arctic Fleet by the Belomorsko-Beltiyskiy Canal.

The West Germans believe a strong NATO missile strike shield—land-based and offshore—will deter local Communist aggression to the point of lending credibility to the idea that a land war will be won by the West.

Russia, significantly, has been more violent in criticizing West German defense efforts than those of other NATO allies.

Last week's German procurement of *Seacat* missiles is believed to be a step in the direction of deterring Russian plans for aggression at all levels. ⌗

—when and where—

American Society for Quality Control, Annual Convention, Sheraton Hotel, Philadelphia, June 5-7.

International Instrument Automation Conference and Exhibit, Instrument Society of America, Royal York Hotel, Toronto, Canada, June 5-8.

National Electrical Manufacturers Association, Western Conference. Biltmore Hotel, Los Angeles, June 8-9.

Manufacturing Chemists Association, 89th Annual Meeting, The Greenbrier, White Sulphur Springs, W.Va., June 8-10.

European Federation of Chemical Engineering, Thirtieth Meeting, Frankfurt-am-Main, Germany, June 9-17.

American Society of Mechanical Engineers, Statler-Hilton Hotel, Los Angeles, June 11-15.

Third National Symposium on Radio Frequency Interference, Institute of Radio Engineers, Sheraton Park Hotel, Washington, D.C., June 12-13.

Instrument Society of America, Third International Symposium on Gas Chromatography, Michigan State University; East Lansing, June 13-16.

Joint ARS-IAS Meeting, Ambassador Hotel, Los Angeles, June 13-16.

American Society of Mechanical Engineers, Applied Mechanics Conference, Illinois Institute of Technology, Chicago, June 14-16.

American Rocket Society, Semiannual Meeting, Biltmore Hotel, Los Angeles, June 14-17.

American Society for Testing Materials, Annual Meeting, San Francisco, June 16-21.

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Harsh Decision at Paris

THE BIENNIAL PARIS AIR SHOW, in addition to being always a colorful event, is one of the best sales showcases in Europe for American products. For that reason, more than 15 major U.S. manufacturers set up exhibits at the show which has just ended.

As usual, it was a successful exhibition, attracting top engineers and military officials from throughout the world. Some 14 nations displayed their wares in more than 300 exhibits.

We must admit, therefore, that we are more than puzzled at the State Department edict which forced the U.S. missile industry to take a back seat at the show. Intent of the decision, as we understand it, was to emphasize U.S. devotion to "peaceful" uses of space.

Result of the decision was to make the Free World's foremost missile industry appear a bad third to Britain and France, which are years behind this country in missile developments.

The effect of this on U.S. sales efforts in Europe is hard to measure but it certainly did them no good. A number of industry executives, engaged in competition with European rivals for NATO awards, quite rightly are concerned about this sabotage of their sales campaigns.

Let's take a look first at why the Administration reached this decision, which we are told came from the highest levels. President Kennedy, now in Europe for talks with General de Gaulle and Premier Khrushchev, apparently wanted to soft-pedal the more aggressive aspects of the U.S. armament effort.

The edict prohibited display of any U.S. offensive missiles or any models of these larger than half-scale. It came in the middle of industry and military plans for an impressive U.S. missile display at Paris.

Illogically, there was no ban on appearance at the show of the Convair B-58 bomber, Lockheed F-104 or Navy attack aircraft. The reasoning under which these presumably were considered "peaceful" while missiles were not, was not explained.

From a political standpoint, we cannot quite understand the advantage of going into talks with Premier Khrushchev carrying a soft stick. He is a man with little respect for anything but a balance-of-power approach.

But it is not the political approach with which we are concerned here. It is the effect on the competitive position of U.S. missile/space firms in Europe. If there were a sound reason for the damage done, U.S. firms certainly would go along with it without objection. But it appears to have been done without a sound reason.

We are not going to fool anyone, certainly not the Russians, by pretending we don't manufacture and sell offensive tactical missiles. That's a little too naive and idealistic for the most gullible to stomach.

What then has been the effect? Let's look at a specific case. The Martin Co. has been engaged in a sales fight with Nord Aviation to sell the *Bullpup* to NATO against the *AS-30* air-to-surface weapon. A decision is due this month.

Nord displayed its *AS-30* at Paris, was quite open with design details and performance figures. Nord officials were quick to emphasize the comparative advantages of *AS-30* over *Bullpup*. Nord's position in this was entirely honorable; it is trying to sell its product to NATO countries and was quite frank about its sales pitch.

The Martin Co., on the other hand, found itself in the distressing position of having to compete with not one, but both hands, tied by the U.S. government.

First, it was unable to display even its early *Bullpup A* missile at Paris. Second, it was in a position where it could not even counter rumors about *Bullpup* performance without breaching security.

THIS IS NOT an isolated instance. No matter what the missile product, foreign manufacturers invariably have a huge lead in presenting the customer with enough data for decision-making. If we are willing to make these weapons available to Allied countries, we should be prepared to make the information available in advance on which they can make intelligent purchasing decisions. Any other method is a needless handicap which benefits only the European competitors of the U.S. missile/space industry.

This complaint does not come solely from the American manufacturers. While U.S. military and government spokesmen were going out of their way at Paris to emphasize the technical flow of knowledge which the U.S. is providing to Europe, French and British industry representatives were complaining privately at the lack of information from this country.

We heard strong objections from an executive of one European subsidiary on the restrictions placed on information from its U.S. parent firm.

Certainly, there are sound reasons for protecting the flow of classified information out of this country. But it is apparent from U.S. government actions at Paris, and from feelings voiced there, that unnecessary red tape and arbitrary decisions are hampering both the sales efforts of U.S. missile/space firms abroad and the advancement of the Allied technical defense effort.

William J. Coughlin

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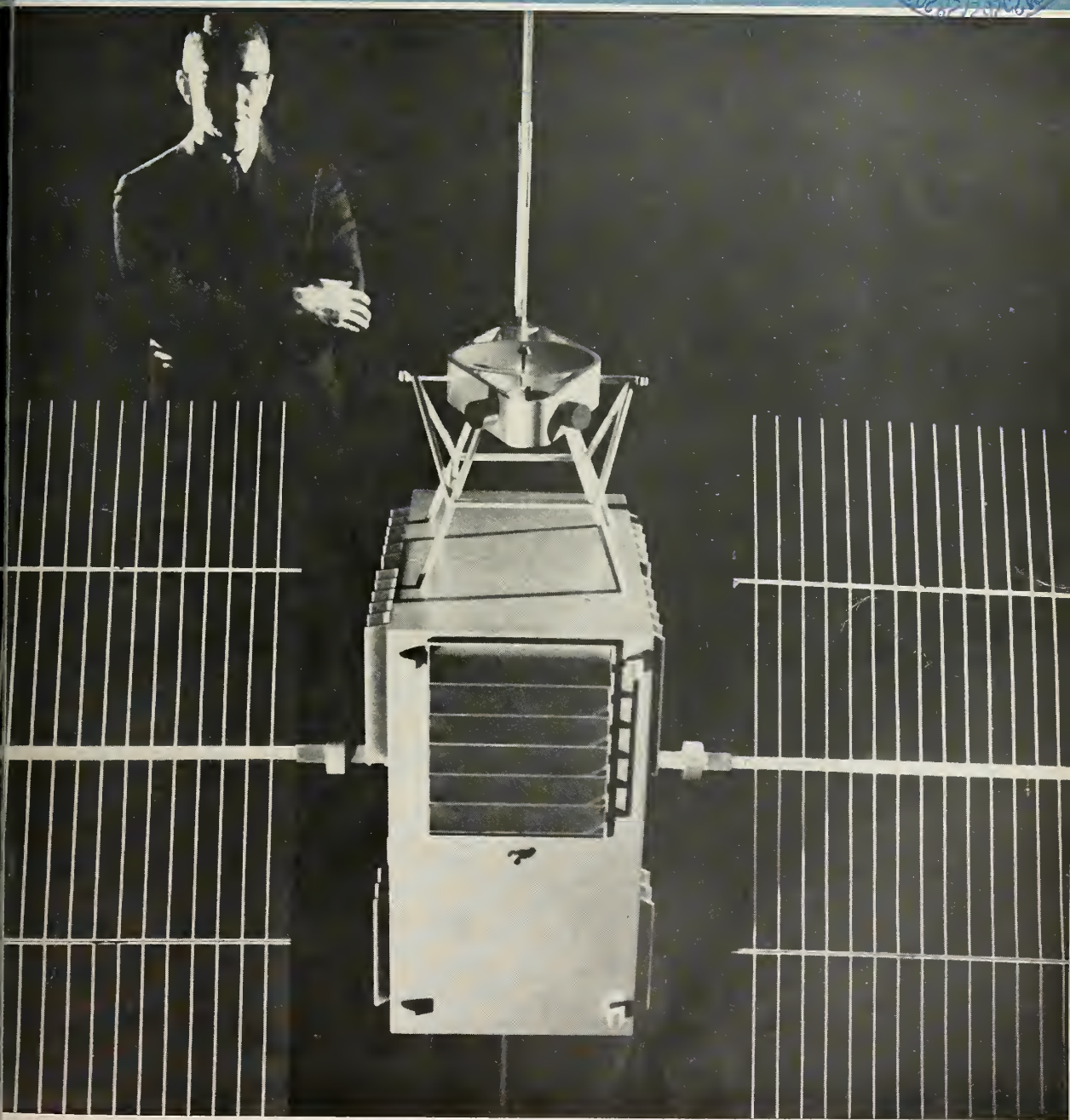
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THE MISSILE/SPACE WEEKLY

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Dean Space Drive Labeled Unworkable . .
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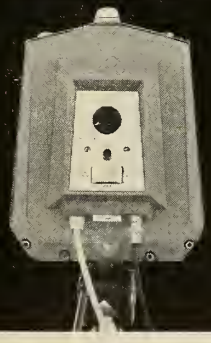
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new! low-cost self-contained TV camera provides 650 line resolution!







Control panel detaches from camera for remote operation via stock cable

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The 20/20 is easier and less expensive to install, operate, service. Yet it gives the sharpest, clearest pictures in the industry – 650 lines of horizontal resolution. It is so sensitive that you can get usable pictures with as little as one foot candle of illumination–less than the light now falling on this page.

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Many standard accessories custom-fit the 20/20 to your exact needs. A light compensation circuit automatically adjusts the camera for light variations as great as 4000:1. Motors provide remote control of the lens turret, lens focus, and a lens-speed filter. Sync generators assure 2:1 interlace either in the standard industry-wide sweep/scan pattern, or in the FINELINE pattern that gives you greatly increased vertical resolution. RF modulators make the pictures available on standard TV channels 2 through 6.

Cut costs, reduce errors with one of KIN TEL'S complete lines of high-quality, closed circuit TV. Other companies do. U. S. Steel uses KIN TEL TV to see inside open-hearth furnaces. E. F. Hutton uses one to transmit stock quotations. Los Angeles Department of Water and Power uses KIN TEL TV to check steam plant burners and to view remote water-level meters. The San Francisco Naval Shipyard uses one to guard against pilferage. American Potash & Chemical conveyor lines and warehousing operations are monitored by KIN TEL TV as are radiation studies at General Atomic. The U.S. Air Force uses KIN TEL TV for detailed surveillance of every operational ICBM outside the Iron Curtain. All told, hundreds of KIN TEL TV systems are performing critical and routine jobs safely, inexpensively, tirelessly.

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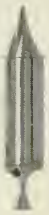
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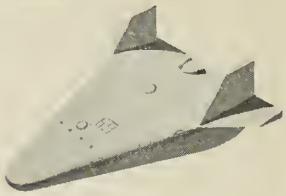
Lunar VTOL Vehicle. A rocket-propelled craft designed to collect lunar ore specimens.



Nuclear Space Ship. An unconventional design by Douglas with living quarters around the ring at the bottom. On landing, it would ease down, ring first.



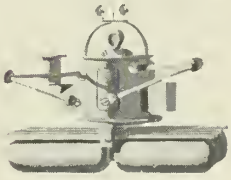
Nuclear Space Ship. A Douglas design for a space ship with crew quarters and control rooms in the nose, nuclear reactor in the rear.



Supply and Escape Vehicle. A compact re-entry vehicle to supply orbiting space stations or to return crews to earth.



Nuclear Space Ship. A future, medium-thrust, nuclear-electric space ship for one-year interplanetary round trips (Martian and Venusian).



Lunar Service Vehicle. Travels like a "swamp buggy" on inflated rollers. Mechanical arms provided to handle outside chores.



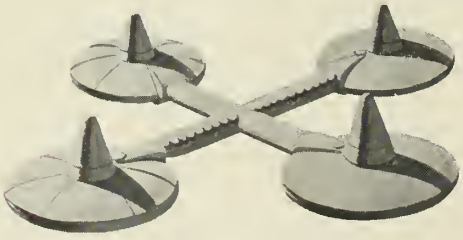
Douglas Thor. Designed as a military IRBM, this dependable missile is the workhorse of the Space Age.



Saturn. First U.S. vehicle designed to put tons of payload into orbit . . . or onto the moon. Douglas-built second stage is as tall as a 4-story building.



Lunar Cargo Handlers. Would load lunar ore samples into containers to be towed back to earth by rockets.



Space Observatory. Sections of this Douglas-designed space station would be sent into space in rockets and be joined together in orbit.



Lunarmobile. Donut-shaped exploration vehicle to use rocket power in space and tractor treads on the moon's surface.

Eleven ways to outwit the law of gravity

When the Space Age dawned, Douglas was ready with specific proposals for space equipment either completed or in advanced stages of development. (Some appear above.)

These Douglas proposals were based on *realistic* estimates of the capabilities of men and materials. They are the valued dividends of the company's considerable experience, gained from the design and production of 30,000 missiles and rockets. These include the Douglas *Thor*, an IRBM which has been totally successful in 86% of its tactical and space firings over the past two years.

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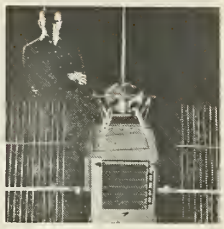
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THE COVER

Model of Army's Advent communications satellite shown by General Electric, contractor for the vehicle. First flight test of the 24-hour system is due soon. See p. 13.

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letters

TV as Evidence

To the Editor:

I should like to add a thought to your editorials on the recent *Mercury* firing. It has been argued that our full and open coverage of the firing provided proof that our space claims are honest, in contrast with those of Russia. Do we really know what we are doing when we assert that television coverage constitutes proof? We are furnishing the Russians a standard. If they have fabricated space achievements in the past, they will surely not shrink from filming a moon landing on a movie set and then running it on television as live material. In a closed society, this would be quite simple.

If we argue that television coverage is the seal of legitimacy, we will appear to be poor sports when we challenge Russia's claims to having landed on the moon in a plastic-domed bathtub.

J. N. Gadel
Consulting Physicist
East Orange, N.J.

Standardization Ideal

To the Editor:

You have coined a word that should be struck from the vocabulary.

The implication behind your article "Telemetry Can be Over-Standardized" (M/R, May 29, p. 26) illustrates one of the most misunderstood elements of our technological endeavors—and this misunderstanding, I sincerely believe, is one of the basic causes for many delays in our technological progress—and one that must be corrected if we are ever to "catch up."

I contend that it is impossible to "over-standardize." Actually standardization is merely the act of recording the *current* state of the "art." To over-standardize would, therefore, imply the recording of the future state of the art—which is obviously impossible.

As a former Director of the Military Standardization Program, I am fully aware of why so many scientists and engineers have developed a fear of standardization. I will admit I failed utterly to correct the discrepancies which engendered these fears. This Program was, and still is, a "horse and buggy" operation trying feebly to keep in the race of modern technology which is bounding forward at supersonic speeds. Instead, this Program should be—and most important, could be—one of the most potent forces in the advancement of our sciences. It can never, however, achieve this role as long as it is bound with "red tape" that demands two, three or four years of administrative delays to produce an obsolete standard—and, most unfortunately, just as long to revise one. This "after the fact" procedure can never fulfill the basic requirements of a true standardization program.

Basically what is required is a very dynamic program that would collect, publish and disseminate rapidly the current state of technological knowledge—and one which would rapidly reflect any changes that might occur. A standard would then become what it should be—denoting only something that remains fixed as long as it serves a purpose, and as such is only temporary in nature.

A standardization program based upon these concepts would allay the fears of all, and it would take its proper niche and receive the respect and stature that it rightfully deserves in this era of rapid technological progress.

Can this be done? After a number of years of serious thought and study, I unhesitatingly say yes, the moment someone of authority so wishes. From my experiences, I know it would not be easy—but it could be done.

Incidentally, in respect to this article you might be glad to know that our company will announce very shortly a revolutionary new type of transducer which will eliminate many of the troubles in all areas of telemetry. It will be marketed under the name "Variaducer."

Richard H. Pender
Washington Representative
Mirax Chemical Products Corp.
Washington, D.C.

The Reasons Why

To the Editor:

I want to tell you that I thoroughly enjoyed the editorial in M/R, May 29. I have seen all kinds of reasons why we should go to the moon and, in fact, have several categories of reasons myself that I use in my speeches, but the names that you have for these intrigue me and I want to use them in my speeches from now on.

I am assuming they are original with you and will be giving you the credit not only in my speeches but in any writing I do. If, by any chance, I'm wrong, I am sure you will straighten me out.

Congratulations on a good, colorful idea!

Evan Evans
Executive Director
National Aviation Education Council
Washington, D.C.

Credit for the Panama Theory (that strategic areas in space must be occupied for reasons of national survival) belongs to Dandridge Cole of General Electric (M/R, May 29, p. 86).—Ed.

Suggest Try Isabella

To the Editor:

It is interesting to note your article regarding Columbus's voyage ("New Route to Cathay—Step by Step," by Ralph S. Cooper, M/R, May 29, p. 37). However, additional commentary is warranted to justify the reluctant position taken by the Sovereign State of Genoa. Of primary importance was the lack of decision-making of the Maritime Association for Interna-

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tional Affairs (MAFIA), whose purpose was to devise new means of increasing the treasury reserves. Their delays in policy-making were based on the following factors:

1. There appeared to be no military significance in establishing a new route to Cathay. Thus funding of this ambitious program could not be justified. (All monies had been committed to continuing the cold war with the neighboring state of Padua over establishing the standard length of spaghetti.)

2. The length of the journey was unknown. Academicians suggested delaying the program until the navigational constant—i.e., the distance to the edge of the earth—had been determined. (In observance of the International Geophysical Year, 1492, it was intended to launch a 20-pound bottle tied to a long string to measure this constant. Three previous attempts to launch the bottle had been unsuccessful—one broke on the pier and two others had to be destroyed by rocks immediately after launching, as they floated Eastward rather than Westward.)

3. The question of liquid provisions versus solid provisions for the crew could not be resolved. Solid proponents pointed out that liquid provisions were less storable and took more volume, whereas liquid proponents observed that liquids were more easily digested.

4. The tolerance of the human body to a "waistlessness" state (prolonged starvation) had not been ascertained.

It should be noted that the final committee recommendations on Columbus's voyage were favorable. After due deliberation and weighing all factors, the committee decided to appropriate the necessary funds. Unfortunately, this did not occur until 1512.

Donald D. DeNigris
Massapequa, L.I., N.Y.

Objects to 'Mastery'

To the Editor:

In "The Missile/Space Week," M/R, May 22, the feature entitled "Grind for Astronauts" impressed me considerably. "Aspiring Astronauts" must indeed be considerably more intelligent than the average "aspiring scientist," in view of the fact that neither myself nor any of my colleagues feel, after some seven or eight years of rather arduous pursuit of such studies as thermodynamics, that we have "mastered" the subject. Apparently these young gentlemen are able to master not only one but no less than a dozen or more in six months.

I do not object in any way to giving credit where credit is due, and no doubt these test pilots must be superb specimens of humanity, not only physically but mentally. However, I feel that it would be more reasonable to state that the subjects mentioned are perhaps "introduced" or "scanned." Most assuredly these people come nowhere near to a mastery of any one of these subjects.

Otherwise, I feel your magazine is quite good, and I thoroughly enjoy reading it.

James W. Buchanan
Graduate Fellow, Chemical Physics
University of Florida, Gainesville



ASTRONAUTICAL ENGINEERS . . . to join a group currently making significant contributions to the national space effort. Studies include determination of economical methods for boosting payloads into orbit; maximizing payloads for inter-planetary missions; determination of satellite arrays for full-time weather observations of the earth's surface.

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NEXT STOP: MARE IMBRIUM



One of the primary needs in the next generation of our space program is for a reliable "space bus" to carry a variety of exploratory packages to the moon and possibly the near planets. Once it is injected into a lunar or planetary trajectory, this bus will guide itself to its destination, accomplish a soft landing, activate and release its payload.

The problems involved in the design of such a vehicle, and of the many kinds of lunar and planetary exploration packages it might be called on to carry, are being intensively explored at Northrop. These investigations cover guidance, communications and position sensing systems, thermal and environmental conditioning, structural and material development, systems integration, trajectory and error analysis, computer design, self-contained, automatic ground support systems, and a host of other essential areas.

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The Countdown

WASHINGTON

Sales Push: Boosters for Europe

U.S. big missile makers are engaging in an earnest sales campaign to get European nations to buy large rocket boosters for space work. Martin—for one—is trying to drum up interest in the *Titan II*. Others are following suit. Martin, incidentally, estimates that by 1970 combined gross expenditures by the U.S. and NATO for defense, space and related activities will total about $85 billion a year. Included in this figure is a 50% increase in U.S. military spending.

ICBM Progress in the Tall Corn

Operational *Atlas* ICBM's are understood to be undergoing checkout at the launching sites near Forbes AFB, Kan. Another *Atlas* squadron base nearing completion is at Lincoln AFB, Neb. To date there are about 27 *Atlases* operational at Warren AFB, Wyo.; Offutt AFB, Neb.; and Vandenberg AFB, Calif.

Subroc Production To Start

The Navy is planning to begin pilot production of the Goodyear *Subroc* in FY '62, but the initial deployment date for the nuclear-tipped underwater-to-underwater missile has become somewhat blurred. The submarine-launched *Subroc* was expected to be initially deployed this year. This now appears doubtful.

Apollo HQ Site Sought

NASA is looking over a number of possible sites for its proposed $60-million manned space flight center. Among the possibilities: Moffett AFB, Calif., and McDill AFB, Fla. The new center would become the headquarters for the Space Flight Task Group that now directs the *Mercury* program and will direct *Apollo*. The group now number nearly 800 people; the new FY '62 budget proposes adding 800 more.

A Look Ahead at ASW R&D

The Navy is estimating now that unless it receives a big step-up in RDT&E funding the ASW slice will continue to run between $200 million and $250 million over the next three years. The Navy is requesting $235 million for ASW RDT&E in FY '62. Meantime, the FY '62 budget contains $8.3 million for anti-ASW R&D work in the field of ship noise reduction.

What's-in-a-Name Dept.

The Air Force is being forced to turn its attention from possibly more important things to thinking up a new name for *Saint*—the RCA satellite inspection program. There have been some strong objections to the name from various groups—apparently with enough political push to get the Air Force project-naming people to reconsider *Saint*.

INDUSTRY

Vela Contracting Under Way

DOD's Advanced Research Projects Agency is moving ahead with contracts on the *Vela* program for detecting nuclear explosions underground and at high altitudes. Geomeasurements Division of United Electrodynamics has one award for more than $500,000 to supply seismic instruments to 125 earthquake-reporting stations around the globe. General Electric's TEMPO (at Santa Barbara, Calif.) received a $233,000 contract to develop recommendations for a world-wide system of ground-based instrumentation for detecting nuclear explosions in the upper atmosphere and near-space.

R&D Intelligence

North American's Rocketdyne Division is building a $300,000 solid propellant R&D facility near Reno to test-fire small batches of advanced fuel. . . . Movement by Aerojet-General into the big solid booster field is prompting the company to set up a separate Space Propulsion Division. . . . Recent record-setting *X-15* speed run was preceded by a *Judi I* high-altitude wind information rocket fired by NASA over PMR to a height of 240,000 ft. . . . Latest *Discoverers* are being equipped with radio command guidance instead of autopilot in the *Thor* booster stage.

Bullet Cores for Surplus Food

New twist in DOD procurement contracts: The Army has let what is believed to be the first barter contract in its history. Army Ordnance has purchased about $8 million worth of bullet cores from Firth Sterling of Pittsburgh—with some 30% of the contract payable in surplus agricultural products from the Commodity Credit Corp.

INTERNATIONAL

Belatedly—An RAF 'Space Force'

Britain's Royal Air Force has finally decided to set up a special "Space Force" to cope with the threat of space weapons. Systems required may include satellite inspection and destruction by ground-based weapons, and the employment of navigation and communications satellites.

Overseas Pipeline

Hungarian Communist Boss Kadar claims his country needs rocket weapons for defense. . . . De Havilland and Matra are expected to collaborate on an air-to-air missile based on the *Matra 530* for sale to NATO countries. . . . COUNTDOWN hears an attempt to get Project LIL (Lunar International Laboratory) under way will be made at various international astronautic meetings in Washington during October.

Gagarin's Big Booster

U.S. space scientists are now calculating that the booster which put Russia's Yuri Gagarin into orbit April 12 had from 1.3 to 1.8 million lbs. thrust. These are extrapolations from the sketchy details filed by the Russians with F.A.I. (20 million h.p. total thrust, 10,395 lbs. total payload, apogee 203 mi). Takeoff was from "cosmodrome" at Baykonur near Aral Sea and landing near Smelovka in Siberia. F.A.I. will decide July 17 at Paris whether to accept both U.S. and Russian space flight record claims.

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The Missile/Space Week

Shots of the Week:

An advanced model *Atlas-E* blew up at launch on June 7 and wrecked a $2.2-million "Hollywood Hard" operational system test facility at Vandenberg AFB.

It was the first attempt at launching the E-series from the semi-hardened launch pad, and the first use of production operational equipment. The test, planned for 4000 miles, was to confirm operational compatibility of all component systems—missile, launch procedures, ground support facilities.

The series E, with 390,000 lbs. thrust, has 30,000 lbs. more than series D. Cause of the explosion was not immediately known.

An *Aerobee-Hi* rocket carrying a weird flower-like trap to capture space dust was launched and recovered at Holloman AFB June 6.

The experiment, supervised by the Air Force Cambridge Research Laboratory, sought to pick up samples of micrometeorites between 40 and 100 miles above the earth. Results are being evaluated.

SAC Bomber Dividend

House-Senate conferees approved a compromise $12.5 billion FY 1962 military procurement authorization bill carrying $525 million more than the President's request for manned long-range SAC bombers.

The bill overrides the House request for only $337 million for B-52H (carrying *Skybolt*) and/or B-58's. Choice of plane is now left to the Department of Defense.

NERVA Team Chosen

An Aerojet General/Westinghouse Electric team has been picked as contractor for the first phase of the *Nerva* nuclear rocket engine.

The two were among seven companies which submitted proposals on the joint NASA-AEC project.

Terms of the R&D contract, set for six months, will include engine design work supporting Los Alamos Scientific Lab *Kiwi-B* reactor tests, and preparation of a developmental plan with costs and work required to meet a feasible flight schedule date.

Nerva is part of Project *Rover*, a joint NASA-AEC nuclear rocket propulsion program. Contract amount was not disclosed.

Other companies which submitted proposals for the program are American Metal Products Corp., General Electric, Pratt & Whitney, Rocketdyne and Thiokol.

Shepard in AOK Shape

A weight loss of three pounds and a slight blurring of vision was the inconsequential payment exacted from Alan Shepard for the *Mercury Redstone* flight.

At a press conference held in Washington, doctors said Shepard is in superb condition and has no permanent effects from the experience.

Shepard described the blurring of vision—which occurred during 15 seconds of the capsule's greatest vibration—as slight. He asserted he still could have seen warning lights had they flashed.

Water-filled Atlas Version

A "swimming pool" 80 ft. deep has been built by Convair to test the *Atlas* launcher mechanism at Vandenberg, AFB, Calif.

Called "Water Bird," the "pool" is an iron shell identical in size and shape with the new Series F *Atlas*. It has a capacity of 28,000 gallons of water. For testing, the Water Bird replica is lowered into the *Atlas* underground silo. Water is then pumped



"WATER BIRD" Atlas poised over silo

in, providing the same weight distribution as a fully-fueled Series F missile. Included in the checkout are electrical, launch platform drive and balance systems.

Specifically, the tests will determine that silo equipment specifications meet exacting tolerances. Two systems, electrical and launch platform drive, will be put through a series of operations to establish whether they function dependably under prescribed conditions.

In addition to tests, Water Bird will provide realistic training for SAC launch crews before they are assigned to operational bases.

FCC Hard Pressed

The problem of who should own and operate the proposed communications satellite system has yet to be solved by the Federal Communications Commission.

At hearings held last week, the conflict continued over whether only international carriers—as FCC proposes—should be allowed in on the venture. General Electric, as an equipment manufacturer who wishes to participate, led the dissent.

Justice Department representatives urged a wider base of ownership to reduce the possibility of a monopoly and to promote research and development.

The FCC is trying to move ahead by forming an *ad hoc* committee to set up objectives and a plan of action. However, even the question of who in industry will be asked to sit on the committee remains to be resolved.

Soviet Research Chief Dies

The head of the powerful new Soviet supercommittee for research died suddenly last week of a heart attack.

Sixty-year-old deputy premier Mikhail Khrunichev had been named research head several months ago under the recent Russian reorganization (M/R, April 24, p. 34).

The Soviets have not announced a successor to the key post.

York Recalls Duplication

Dr. Herbert York, former DOD R&E chief, has cited the *Thor* and *Jupiter* development programs as instances of "unwarranted duplication."

In Congressional testimony just released, York also said that the *Atlas* and *Titan* programs had some undue complication and occasional duplication. But in the latter case, "it would have required an inhuman degree of foresight" to avoid it, he said.

The testimony was given before the House Mahon Subcommittee in April.

Aerojet Fires Biggest Solid

The largest solid rocket motor ever assembled in the U.S. was successfully fired by Aerojet-General Corp. A half-million pounds of thrust was produced by the 50 tons of solid propellant in the 8 ft. 4 in.-diameter, 30-ft.-long assembly of three segments.

Vibrations from the firing were felt over 60 miles away. The smoke cloud was visible up to 30 miles away.

The motor was made up of three segments joined together just before firing. Aerojet said this would make it easy to produce, transport and assemble at a launch site. Field engineers claimed it could be assembled in less than five minutes.

Dan Kimball, Aerojet president, said that more segments could be added to the motor to increase its power.



INSIDE record solid-rocket motor casing.

The 55-ton rocket motor was third in a series tested under the Air Force solid-rocket motor program at Aerojet's Sacramento plant. Subscale motors of 20 and 25 tons were fired earlier this year. The program is under technical direction of the Directorate of Rocket Propulsion at the AF Flight Test Center, Edwards AFB, Calif.

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After redesigning . . .

Titan Superbooster by 1963

Details of FY '62 R&D by services; hassle over Zeus continues; new timetable is set for booster development

by James Baar

THE PLANNED acceleration of the National Booster Program is expected to produce its first payoff in the form of a *Titan II* superbooster in about 18 months.

The Air Force is understood to be aiming at redesigning the Martin *Titan II* ICBM with new staging that would provide a space booster with possibly as much as 750,000 to 800,000 lbs. of thrust. That would be more than twice the present thrust of the *Atlas* and about equal to the lowest figure usually estimated for the Soviet Union's big boosters.

The extra thrust for *Titan II* is expected to be supplied by a new high-energy liquid-propellant upper stage that probably will take the place of the present second stage.

However, a number of other proposals are being considered. These include such ideas as adding the new stage to the present second stage, the use of off-the-shelf solid-propellant motors for upper stages, and the clustering of solid-propellant motors to the side of the *Titan II* first stage.

• **Breakdown**—Plans for the National Booster Program were learned as Congress released new details of military R&D programs for FY '62:

—Air Force appropriation requests include $74.5 million for *Atlas,* $358 million for *Titan,* $380.5 million for *Minuteman,* $276 million for *Samos,* $201 million for *Midas,* $26 million for *Saint,* $54.9 million for *Discoverer,* and $267 million for advanced systems. The funding for the three ICBM's completes their development. *Samos* funding is about the same as last year, when it reached $273.8 million; *Midas* is almost doubled.

—The Army is requesting $87.1 million for R&D on the 350-mile-range *Pershing* (see below). That will bring to $459.1 million the total R&D cost of *Pershing* through FY '62. Army proposals to develop a 1000-mile-range *Pershing II* are still on a Defense Department shelf.

—The sharp split in Defense Department and Army opinion over the value of *Nike-Zeus* continues. Dr. Herbert York, recently resigned Pentagon R&E Chief, testified: *"Zeus* is highly vulnerable to the use of missile penetration aids (decoys, jamming and so forth.)" The Army denied it.

—The Navy is seeking $17 million for the *Transit* navigation satellite; $443 million for *Polaris;* $7.7 million for the Atlantic Undersea Test and Evaluation Center (AUTEC). The FY '61 appropriation for AUTEC was $5.7 million.

One of the principal reasons being advanced for rapid development of the *Titan II* space booster is the need for additional thrust to place the first *Advent* communications satellites into 22,000-mile orbits in 1963.

Deputy Defense Secretary Roswell Gilpatric told the Senate Space Committee that the *Atlas Centaur,* scheduled for use as the booster for *Advent,* "looks as if it might not be large enough."

He said *Atlas Centaur* would have had sufficient thrust for the 1250-lb. *Advent* planned earlier. But the weight of *Advent* now has been increased (see p. 13). Gilpatric said the planned *Titan II* booster would be able to put one-ton payloads into 22,000-mile orbits.

• **ETA's**—The new timetable for development of new boosters under the National Booster Program is shaping up like this: The *Titan II* space booster—operational in 1963; *Saturn C-1*—operational in late 1963-early 1964; liquid-propellant *Nova* and solid-propellant *Nova*—static firings in 1964; *Rover* nuclear-powered booster—flight tests in 1965-67 and manned flights about 1970-71.

Gilpatric expects a choice between the liquid and solid *Novas* for NASA lunar landing work will be made about late 1964.

He also suggests that by then the Pentagon might have a "military requirement" for a multimillion-lb.-thrust booster. Few top Air Force officials would disagree. ⌘

Trudeau Lashes Back at Pershing Critics

THE MARTIN *PERSHING* system underwent a heavy drubbing in newly-released testimony before the House Defense Appropriations Subcommittee. At the same time, the Army retorted with some hard-hitting statements in defense of the biggest of its second-generation solid-propellant missiles.

The criticism (presented in the form of a memo by unidentified authors):

• *"Pershing* is not sufficiently mobile. To carry the missile, its related computers, radars and so forth, requires four track vehicles. The system is very cumbersome for air transport. . . . The *Pershing* is not air-droppable."

• "The missile is not useful in non-nuclear war. The expense of using such a vehicle to deliver high explosives . . . is probably prohibitive. (Also) maybe the accuracy is not good enough for the use of mere (high) explosives."

• "The *Pershing* system will depend somewhat on drones for reconnaissance. The drone development program has run into difficulty."

The answers (given by Lt. Gen. Arthur Trudeau, Chief of Army R&D):

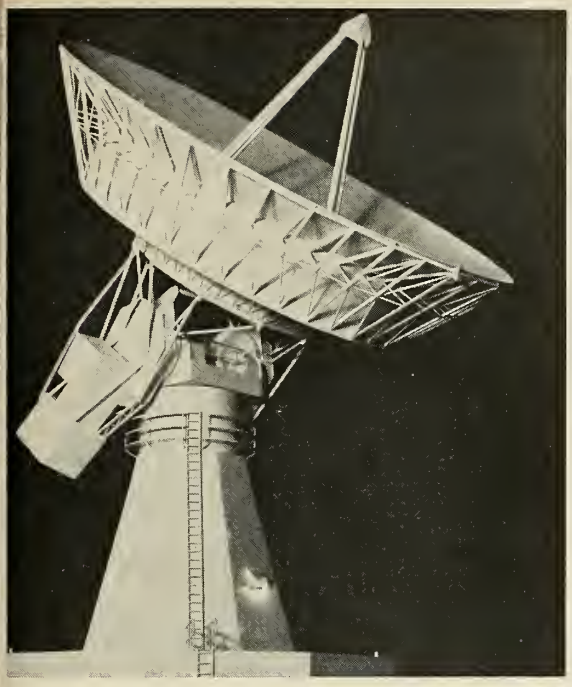
"This is another one to cut down on efforts that are being productive . . . with nothing positive offered to substitute for it. This is typical of some of the very dangerous thinking I think we have in this country. We have stated the characteristics and the characteristics as stated to number of vehicles it takes to move them is perfectly true. Once this system is on the primary land mass with a track vehicle we are not concerned with the limitation of roads and we have a range which gives us the greatest flexibility."

"I would like to record (that in World War II it took) three days and 200 bombers launched from England to destroy an armored division located east of Paris when . . . in 30 minutes one *Pershing* could have destroyed that division.

"So it is not the answer to all our prayers or anything of the sort. Nevertheless, we think we have here a missile that has been developed and well be in production and delivered to troops . . . that is an outstanding example of missilery."

Further testimony noted that the Army's *SD-5* drone was "somewhat behind schedule" but has "been performing very well" and will be procured with FY '62 funds.

Asked whether there is anything on drawing boards that supersedes the *Pershing,* Trudeau said: "No. Nothing approaches it." ⌘



MODEL of antenna towers being built by Sylvania for ground stations in Advent satellite test program.

Weight Added To Army's Advent

Military communications satellite will now weigh more than 1250 lbs.; system's contractors disclose new design details

NEW DESIGN requirements are forcing an increase in the weight of the Army's *Advent* communications satellite.

Earlier plans had called for a 1250-lb. satellite. The latest weight is now officially described as "somewhat more" than this figure. Nature of the weight increase is classified.

However, some more technical details of the system—scheduled for first test launching on an *Atlas-Agena* this year—became available last week.

The *Advent* program is an R&D project to determine feasibility of a microwave-repeater satellite complex to improve worldwide military communications. Eventually, a minimum of three satellites would be placed in 24-hour equatorial orbits, spaced 120° apart. Ideal orbit will be at an altitude of 22,300 miles as nearly circular as possible.

The more-than-1250-lb. satellite will receive, amplify, and re-transmit radio signals from station to station.

Prime contractor for the nearly $200-million Signal Corps program is Bendix Corporation's System's Division at Ann Arbor, Mich. General Electric will develop the space vehicle and associated power, control, and electronic equipment under direction of the Air Force's Ballistic Systems Division. The Army Signal Research and Development Laboratory at Fort Monmouth, N.J., will provide project management and direct technical support.

Conceived first in the fall of 1958, *Advent* evolved in February, 1960, from three programs contemplated during 1959 (*Steer, Tackle,* and *Decree*).

• **Initial test program**—Early system flight tests will be at relatively low altitudes with a six-hour period. Because of the shorter flight path, the tests of the control system will be much more severe than for a synchronous orbit at the higher altitude.

Initial studies will cover the power equipment (solar cells and nickel-cadmium batteries), altitude and orbital control systems (reaction jets, reaction wheels, horizon scanners, and solar sensors), system temperature control and operating environment, plus the complete ground support system.

Windup of the early tests will be trial operation of the complete system and ancillary equipment.

An *Atlas-Agena* will serve as the booster for the low-altitude orbital trials. *Atlas-Centaur* will boost the satellite into its equatorial 24-hour orbit.

• **24-hour orbit**—In the synchronous phase of the test program, the satellite will hover over the equator in the same longitude as Denver. With the *Centaur* launches, some tests will require a transfer ellipse at the proper equatorial crossing; others will go directly into a 24-hour orbit.

During these tests, control will be maintained at Fort Monmouth. The Air Force will be responsible for launch operations at Cape Canaveral and for orbit control tests at its Sunnyvale Test Center in California.

Ground stations for the program are now under construction by Sylvania Electric Products, Inc., at Camp Roberts, Calif. and Fort Dix, N.J. The project includes design and development of towers and superstructures for aiming the 60-foot paraboloidal reflector antennas used at each station for tracking.

A third station will be provided by the Navy. This shipborne facility will employ a 30-ft. tracking dish now under development by General Electric's Ordnance Dept.

For early tracking, telemetry, and system command tests, a fourth station will be used at Kaena Point, Hawaii.

Three antennas will be employed on the satellite: a receiving horn, a relay dish, and an omnidirectional antenna for tracking, telemetry, and command functions.

The real-time repeater subsystem will provide four r-f channels able to handle 12 voice circuits each and an undisclosed number of data circuits.

Each satellite in an operational system will be in direct line of sight of a segment of the earth's surface some 11,300 miles in diameter.

Solar cell paddles will have one degree of freedom to rotate for continuous alignment with the sun. Once each orbital period, the paddles will be flipped to re-orient them for the next orbit.

Batteries will provide power for the 74 minutes of darkness experienced by the satellite when eclipsed by the earth during each period.

Louvers will be provided on the shadow sides of the craft to maintain passively internal temperature within the range of 50-75°F. ⌘

Hitchhiking on Scout . . .

S-55 to Explore Threat of Puncture

NASA satellite is designed to find out whether manned vehicles face real hazards from tiny micrometeoroids

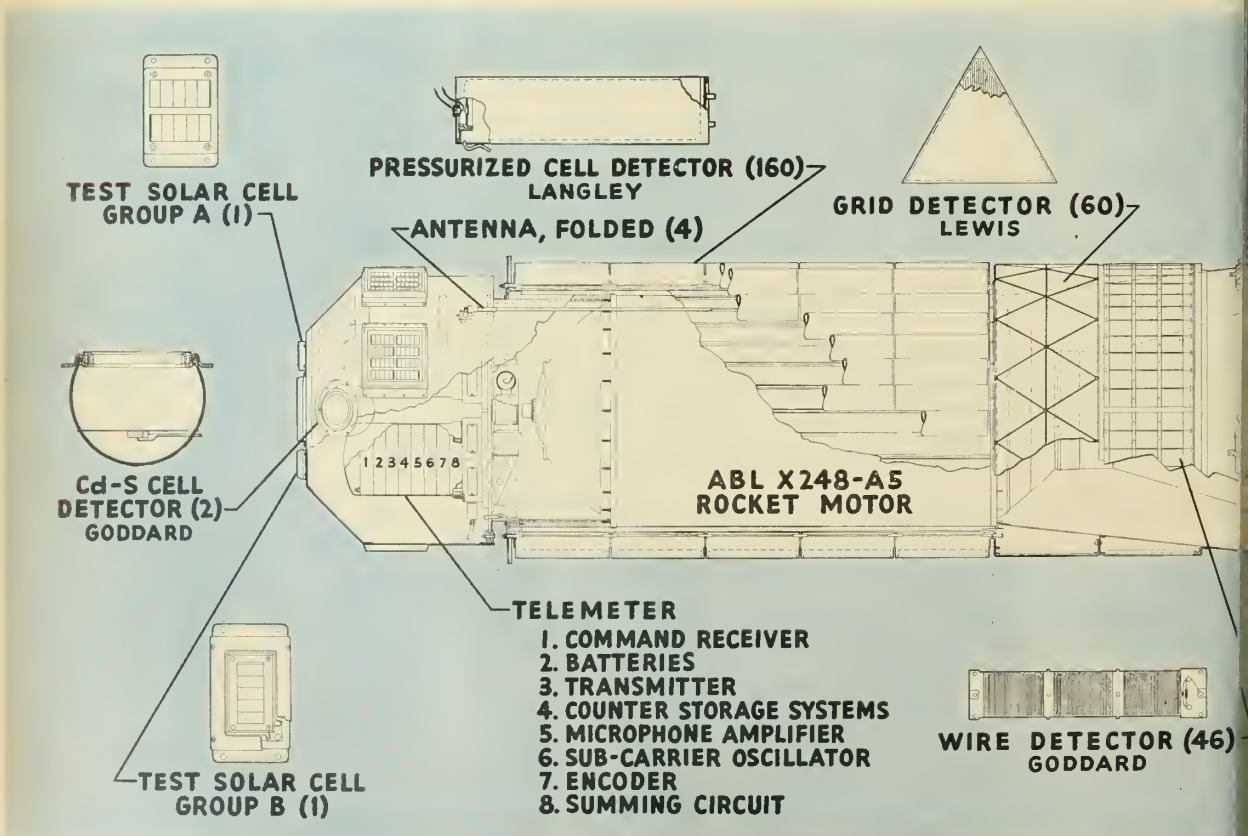
by Hal Gettings

NASA IS preparing an extensive investigation into the micrometeoroid puncture hazard to manned spacecraft, beginning with the launch of an *S-55* satellite—probably this month—aboard a *Scout*.

Today, the damage potential of these tiny high-velocity particles—sometimes called "space dust"—is largely unknown. Yet they pose a critical question affecting every vehicle put into space, in the opinion of M. J. Aucremanne, *Scout* payload project officer.

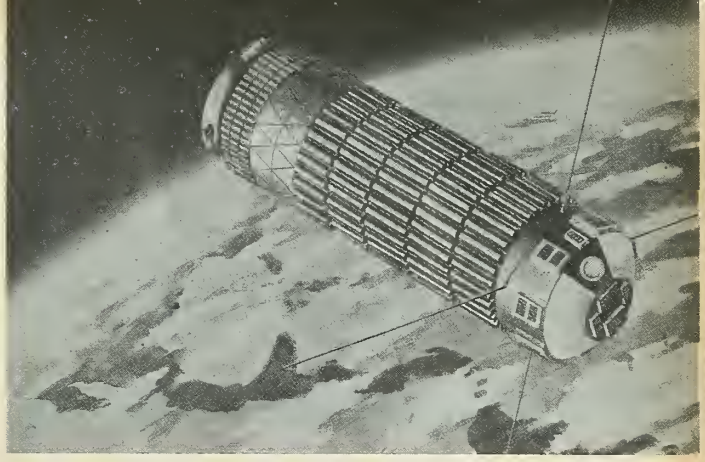
The danger of explosive decompression to a manned spacecraft is only one phase of the investigation. Answers will be sought for structures and propulsion people as well.

The space agency currently is considering follow-on proposals to explore the problems of stabilizing and orienting micrometeoroid data-gathering satellite, optimum orbits and building vehicles with larger surface-area collectors. Some of the later satellites in the program would be fired into polar orbits.



S-55 CARRIES five types of instrumentation to register impacts and penetration of "space dust" particles.

om 'Space Dust'



Eventually, investigators will try to tie together information gained from satellites with that obtained from ground experiments using hypervelocity guns to simulate meteoroid impacts.

• **Objectives**—The end product, NASA hopes, will answer the "big questions." Are micrometeoroids a real hazard to space vehicles? What are their velocities and penetration capabilities? What is the probability of penetration? Do they exist in "clouds" or are they more or less uniformly distributed? If necessary, how do you shield against them?

It's hoped that *S-55* will shed considerable light on the problem. As presently programed, this first mission has four objectives:

—To obtain direct measurement of micrometeoroid puncture hazard in structural skin samples.

—To measure influx of micrometeoroids having momenta in the range of 10^{-2}, 10^{-1} gm-cm/sec (and higher), and to correlate these measurements with other data.

—To obtain data regarding erosion of spacecraft material due to small particles in space.

—To obtain data regarding action of particles on solar cells and lead to improvements in cell design.

Simply, *S-55's* job will be to find out the size, number, distribution, and momenta of space dust particles.

Five separate measurements will be made by the *S-55* to gather the required data.

• **Sounding boards**—Two "sounding boards" on the nose of the vehicle, connected to microphones, will measure impact levels of particles hitting their surfaces. One will record levels of momentum of 1 gm-cm/sec; the other levels of 0.01 gm-cm/sec.

• **Cd-S cell detectors**—Two cadmium-sulphide cell detectors, also on the nose, provide measurements of erosion due to particle impacts. The cells, covered by aluminized Mylar, detect the level of light allowed to enter as the opaque aluminum is eroded by the cumulative effect of impacts.

• **Pressurized cell detectors**—A series of 160 sealed cylinders, covering the vehicle's midsection, are used to measure the penetration force and distribution of particle impacts. The cells are pressurized to 8 psi with a 9:1 mixture of nitrogen and helium. Particles impacting on the cells with sufficient force penetrate the surface and depressurize the cell. This loss of pressure is detected by a bellows switch and the penetration recorded. The beryllium copper cells are divided into five groups, each with a different skin thickness: 0.001, 0.0015, 0.002, 0.0025, and 0.005 inch.

• **Foil gauges**—Sixty grid detectors, or foil gauges, are arranged around the vehicle's circumference aft of the pressure cells. These detectors are composed of a printed resistance grid covered by aluminum foil. Micrometeoroid impacts of sufficient force break the continuity of the grid, changing the resistance value of the circuit to detect the hit.

• **Wire gauges**—Wire gauges (detectors) perform basically the same function as the foil gauges. In this case, fine wire, wound on cards, detect the particle impacts. Forty-six of these cards cover the after section of the satellite. Fourteen are wound with 2-mil wire and 32 with 3-mil wire.

Information gathered by the cells is stored and transmitted by telemeter on command from a ground station. The telemeter is a dual PDM/FM system, each of which handles half the load. In case one system fails, the other will still provide sufficient data to carry on the experiment.

NASA expects the *S-55* to have a useful life of one year. It will be launched from Wallops Island into an orbit of 38 degrees inclination. Programed perigee is 238 statute miles and apogee 600 miles.

The satellite will not be stabilized and will tumble as it orbits the earth. Later research will study the advantages and problems of stabilization of the vehicle.

• **Hitchhiker**—The vehicle itself is actually the rocket motor of the *Scout's* fourth stage with the cell detectors clustered on its skin. An extension on the motor's nose carries the telemetry, power supply, and other system components. Overall, the satellite is 80 in. long and weighs 135 lbs. The spent motor case weighs 50 lbs.

Primary purpose of the launch actually is a development test of the *Scout*. So the payload is merely a hitchhiker.

Several NASA facilities are cooperating on the micrometeoroid project. Langley Research Center is responsible for system integration and overall project management. Langley also has responsibilty for the telemetering system, pressure cell, and sounding board detectors.

Lewis Research Center is responsible for the foil gauge detectors. Goddard Space Flight Center is in charge of the cadmium-sulphide cell detectors and the wire gauges.

During the first two weeks in space the satellite will be commanded to read out data about three times per orbit. Later, as routines are worked out, it will be commanded only once per orbit.

Data from *S-55* will be acquired by Goddard and sent to Langley for reduction. From there the data from the various experiments will go to the respective Centers for analysis. ⌗

Out There, They're 'Oids'

SELECTION of a proper name for S-55 involved some discussion of the relative merits of "meteorite" and "meteoroid." Although popular usage gives preference to the former, many scientists feel this term properly describes only bodies entering the earth's atmosphere. Thus, to differentiate, those outside the atmosphere are, more exactly, "meteoroids."

NASA Gets Huge Saturn Launch Site At Cape

But collapse of river lock blocking barge could delay September firing — officials seek other transportation

THE BIG *Saturn* booster is marooned at Huntsville this week.

The trouble: a collapsed lock on the Tennessee River. It is blocking the path of the barge Palaemon, which was scheduled to carry the first *Saturn* booster from Huntsville to the Cape late next month or early in August to meet a first flight date in September.

Unless an alternate means of transportation is found—and NASA officials are frantically searching for one—the *Saturn* firing schedule may slip. For it is expected to take months to repair the bottleneck.

Several huge concrete sections of the lock, situated below Huntsville, shifted June 2, making it impassable for the barge.

Ironically, the mishap occurred just four days before NASA accepted the giant *Saturn* launch complex 34 at the Cape—where the first flight will be attempted.

Any solution to the transportation problem may be costly, since the Palaemon is tied up at Huntsville. This means that even if the *Saturn* booster is trucked to below the broken lock, another barge will be needed to take it the rest of the way. If this approach is taken, the problem is further compounded by having to convert the new barge, because *Saturn* is supposed to be transported in a sealed, air-conditioned container.

• **Complex turnover**—Cost of the new *Saturn* launch complex was put at $43 million as NASA formally took occupancy. Dr. Kurt Debus, head of NASA's Launch Operations Directorate who accepted the facility in an elaborate ceremony, will direct installation of equipment.

Most imposing feature of the new complex is the 310-ft. service gantry. This 2800-ton tower—the world's largest movable wheeled structure—will be used to erect the booster and assemble the upper stages. Each of the tower legs contains a two-story building; these house the structure's operating equipment and rocket checkout apparatus.

The tower has a work deck at the booster base level and seven fixed platforms at various elevations. There are also five movable, horizontally retracting platforms which can be adjusted to embrace the vehicle at any desired level.

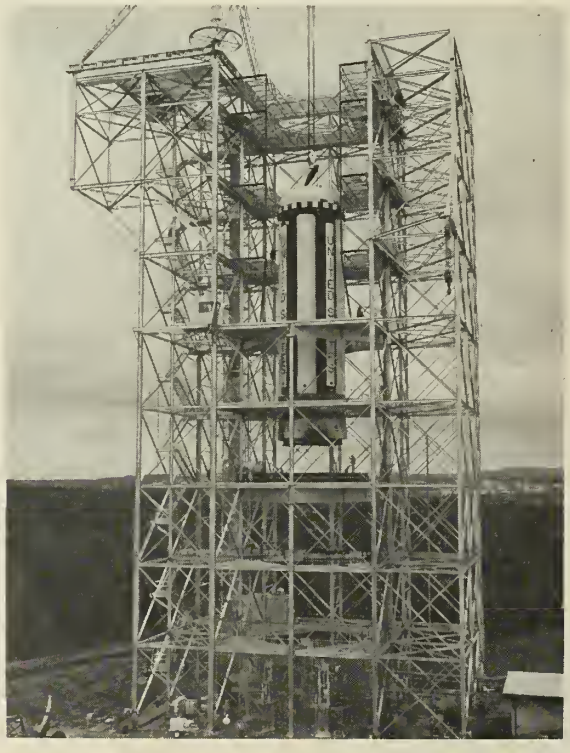
Cost of the structure was approximately $4 million.

The *Saturn* control building is a dome-shaped blockhouse with 12,500 sq. ft. of protected floor space on two levels, and an additional 2150 sq. ft. of unprotected space. It is 156 ft. in diameter.

The inner dome is of reinforced concrete five feet thick. It is covered by a earthfill which varies from 7 ft. in the center to 14 ft at the edges. The final layer is four inches of gunned concrete.

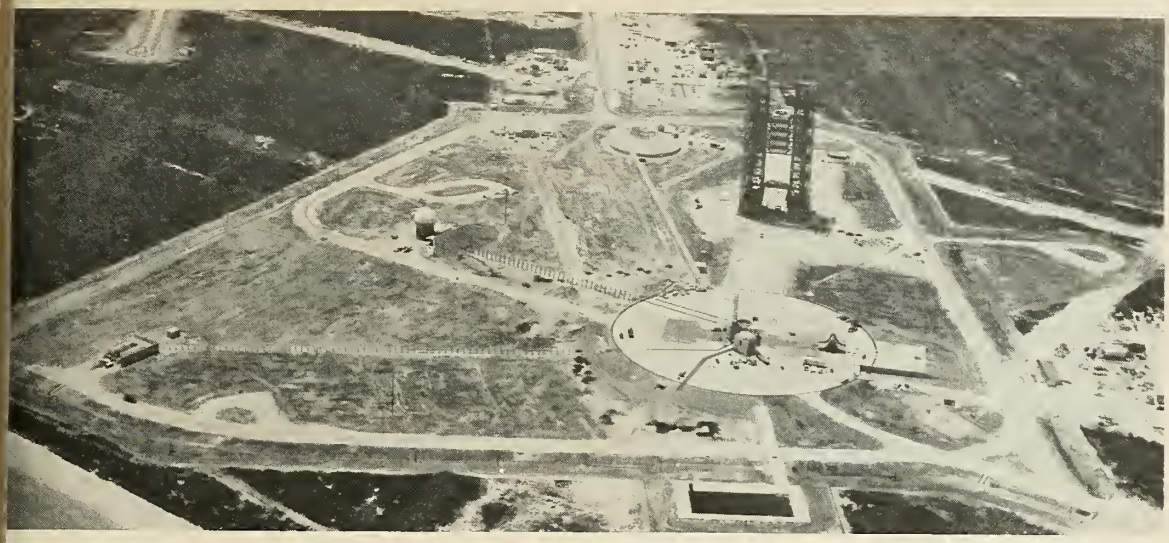
The first floor of the building will be used by booster and upper stage contractor personnel involved in tracking and telemetering operations.

The main firing operation will be located on the second floor. Equipment includes firing console, test supervision and conductor consoles and various monitoring and recording panels.



To Test Complete Saturn

DYNAMIC test stand at Marshall Space Flight Center will be used to test and check out the multi-stage Saturn space vehicle. The new structure will also be used to test fueling techniques, ground crew training, and assembly methods.



AERIAL VIEW of completed $43-million launch complex 34 at Cape Canaveral, where first Saturn flight will be attempted.

• **Thick launch pad**—The launch pad is 320 ft. in diameter, constructed of reinforced concrete eight inches thick. In the vicinity of the flame deflector, the pad is paved with refractory brick to protect it from heat. The pad has a perimeter flume for taking away surface water and possible propellant spillage.

A pedestal from which the *Saturn* will be fired is in the center of the launch pad. This structure is 42 ft. square and 27 ft. high.

A rail-mounted flame deflector is located beneath the launch pedestal. This 60-ton steel structure diverts the 5000°F jet stream in two opposite horizontal directions. The deflector is 20 ft. high and 50 ft. long. When not in use, it is parked on rails away from the pedestal. A spare deflector is parked on the opposite side of the pedestal.

The umbilical tower, located adjacent to the launch pedestal, provides electrical and pneumatic lines to the rocket. At present, the tower is only 27 ft. tall. It will be increased in height —up to 275 ft.—as live upper stages are added to the rocket.

Automatic ground control station is a room just beneath a major portion of the launch pad. This room, 215 by 38 ft., serves as a distribution point for all measuring and checkout equipment, power, and high-pressure gas.

A tunnel for personnel, and for passage of a dozen racks of cables, extends from the AGCS to the other side of the pad. The cables are fed into a roofed cableway which leads to the control building.

• **Fuel system**—RP-1 fuel (kerosene) is provided to the booster from two above-ground tanks located about 950 ft. from the launch pedestal. The 30,000-gal. tanks are 15 ft. in diameter. A retaining wall and revetments are provided to retain the fuel should a tank rupture.

An 8-in. fuel line, fed by two 1000 gpm pumps, leads from the tanks to the rocket. Fuel is brought into the facility by truck transporters, three of which can unload at the same time. The fueling operation is completely automatic, operated from the control building fuel loading panels. Normally, the booster will be fueled in about 40 min., although it could be accomplished in about half that time.

A facility for liquid hydrogen, for the *Saturn* upper stage, is to be ready by the time the live upper stages are phased into the program.

There are two liquid oxygen storage tanks some 650 ft. from the launch pedestal. The main vessel is an aboveground sphere with an outside diameter of 43 ft. The tank is surrounded by four feet of "perlite" insulation which controls the evaporation loss of less than 0.5 percent per day. An earth revetment protects the LOX facility on the side of the launch area. A six-inch line feeds the rocket, at a flow rate of up to 2500 gallons per minute. Normally, about 40 min. will be required to fill the *Saturn* booster's five LOX tanks, but it can be done in much less time.

A small LOX tank is used for replenishing the oxygen which boils off during the latter stages of launch preparation. It is a 13,000-gal. tank located near the main tank. A three-inch line, under 200 psi, leads to the booster.

• **H-P gas facility**—A high-pressure facility for gaseous nitrogen and helium is located 1100 ft. from the launch pad and 200 ft. from the control building. This is made up of 36 15½ cu. ft. storage vessels divided into two groups. Four vessels contain helium for bubbling the LOX tanks of the booster to keep the LOX from forming strata of different temperatures. Thirty-two tanks contain nitrogen for purging fuel and LOX lines, engine and instrument compartments, for air bearings, and for certain pressure-operated components such as valves. All these tanks operate at 6000 psi.

Other equipment in the facility includes two helium booster compressor units, which take helium from trailers and boost it to the desired pressure level, and two 1000-gal. trailer-mounted converters to change liquid nitrogen to gas.

A skimming basin is located about 300 ft. from the edge of the pad on the beach side. This is a paved vat, 104 by 180 ft., for the separation of water and fuel resulting from spillage, or from unloading booster fuel.

A water system has been installed on the pad and throughout the service structure, primarily as a safety measure. This provides for fire protection, a "pad flush" system to wash away spilled fuel, and a quenching system for use in case fire occurs in the "boattail" or engine compartment. This system is also used to prevent back-flame from entering the engine compartment in case the engines are cut off immediately after ignition and before liftoff.

An operations support building, now under construction, will contain about 30,000 sq. ft. of floor space for general shop and engineering activities, and spare parts stowage.

A voice communication system is being installed for clear reliable voice transmission regardless of high noise environment. The system will consist of up to 200 stations scattered throughout the 45-acre installation. ⌘

Morse Attacks Our 'Splintered' R&D

THE "SPLINTERED" approach currently in vogue in U.S. missile/space R&D must end before we can lead instead of lag in the space race, says Richard S. Morse, former Army R&D director.

He blames much of our failure to catch the Russians on lack of national purpose and policy—and lack of honesty in support of certain programs.

In his keynote speech before the 15th National Armed Forces Communications and Electronics Association Convention and Exhibition in Washington, Morse stated flatly that America is steadily losing ground in the technical race with the Soviets. Then in rapid succession he labeled the executive, Congress, industry, and the press as contributors to the present dilemma.

He described five basic causes of splintered R&D:

—The two-party political system (changes in policy and emphasis on programs).

—The three-service military organization (interservice rivalry, duplication).

—The placement of contracts by local need (rather than competence).

—The waste of manpower (on time-consuming but non-productive tasks such as proposals).

—The press (exploiting controversy and failure rather than successes and advancements).

• **It's the system**—Morse softened his verbal lashing somewhat by praising the unpublicized dedication of top military and government personnel. The problem, he said, is not people but the system. And much of the problem is tied in with the "debilitating" influence of the Bureau of the Budget.

He then outlined four recommendations:

1. We must initiate programs and stop attempting always to copy the competition.

2. We must have firm, clear, honest national policy governing our efforts.

3. We must think of and plan for more 10-year programs, then carry them out to fruition.

4. We need some kind of government incentive program, some reward for excellence.

• **Conference expands**—With some 5000 persons attending the AFCEA meeting, and more than 200 exhibits, the meeting was touted as the biggest ever.

It was also the largest electronics exhibit ever held in Washington, said convention chairman Col. W. J. Baird.

Exhibit highlights included three from the military. The Navy demonstrated some of its NAVSPASUR (Space Surveillance System), designed to detect, track, and identify all nonradiating space objects within its range.

The Air Force showed its Combat Logistics Network (COMLOGMET), due to be integrated in the Aerospace Communications Complex in 1962.

The Army provided a good look at its *Advent* (see p. 13).

• **New hardware**—Hoffman Electronics Corp. revealed its new retractable whip-type antenna. Designed for use on submarines and hardened missile sites, it offers a method for covering all radio frequencies from 2-32 mc.

Designated the WRA-2, it uses a helix coil which is a physical part of the antenna to change the electrical length of the system. Peak power capability, the company said, is 5 kw.

Also displayed was General Electric's new image orthicon tube which serves in a combined optical-radar system for missile detection. GE says the units can detect a 2-ft.-diam. black sphere in sunlight 2000 miles away. ⌗

Martin Reveals Advanced Voice Communications

A REVOLUTIONARY voice radio communication system capable of handling 700 two-way conversations simultaneously on one single-frequency channel has just been unveiled by Martin-Orlando.

G. T. Willey, vice president and general manager of the division, says that the system—called RACEP, for random access and correlation for extended performance—is "probably the most significant development in the field of voice communications electronics since the end of World War II."

He sees wide future application in all types of military and commercial communications, including future satellite relay systems.

According to Willey, the mobile radio telephone system provides major gains in spectrum efficiency, transmission reliability, and operational flexibility. As an example of the spectrum-saving features of RACEP, he said that in the area of air traffic control communications alone, he could foresee a reduction of 70-85% in future frequency requirements.

• **New method**—The RACEP system achieves its high performance with a new type of voice-actuated pulse-modulation technique. Voice signals are broken down and coded into microsecond fragments, mixed with similar signals from as many as 700 other circuits, and all transmitted at once over the same channel. Special receivers, preset for the proper code of a specific conversation, receive that conversation and reconstruct its fragments back to normal speech.

The equipment is the equivalent of a private radio telephone system which has all the operating characteristics of an ordinary telephone system without the use of wires or central switchboards. A subscriber can "dial" any other subscriber and talk privately with no interference.

In more technical detail, the speech waveform is sampled and converted to a modified form of pulse-position modulation (PPM). Each PPM pulse is address-coded by transmitting it as a group of sub-pulses, each sub-pulse being transmitted at a different carrier frequency. Time delays corresponding to the desired address code are inserted between the sub-pulses prior to transmission.

At the receiver, detection of a transmitted pulse group is accomplished by envelope-detection of each sub-pulse and insertion of complementary delays followed by coincidence-gating. Therefore, all sub-pulses must be present in the proper time slots for the full PPM pulse to be present at the output of the decoder. The pulses at the decoder output are fed to a nonsynchronous PPM demodulator which regenerates the original speech-input signal.

The use of pulses very narrow in relation to the sampling period allows many signals from different transmitters to occupy the same common frequency channel with only a small amount of mutual interference or crosstalk. Minimum pulse-density, and therefore minimum crosstalk for a given number of users, is achieved by using nonsynchronous PPM and voice-actuated transmission.

• **Reducible**—Present models of the RACEP discrete address units are 14 x 14 x 12 in. and weigh less than 35 lbs. Battery-operated from a 24-30 vdc supply source, power consumption is less than 200 watts. Units can be mounted in vehicles or man-carried for mobile use. If required, Martin says, the RACEP units can be reduced considerably in size, weight, and power consumption. Capacity and range are expected to be increased with further development. ⌗

Attn. commuters . . .

Over Hill, Over Dale in Army's New Rocket Belt



LOCATION of exhaust nozzles away from body makes protective devices unnecessary.

AN EXPERIMENTAL rocket belt, capable of flying a man up to 360 ft. distance at 3 to 4 ft. altitudes, has been developed by Bell Aerosystems Co., under an Army Transportation Research Command contract.

System weight and performance details were not disclosed, but test engineer H. M. Graham, who has made all of the free flights, weighs 180 lbs. before strapping the small rocket lift device (SRLD) on his back.

The unit is a feasibility model and is not designed to meet specific military requirements. Basically the system consist of a twin-jet H_2O_2 propulsion unit mounted on a fiberglass corset. Metal control tubes extend forward on each side of the operator. One tube controls the flight direction and the other the rocket thrust level.

Pitch and roll are easily controlled by the operator's body. When activated by the pilot, H_2O_2 is forced under pressure into a gas generator, where contact with a catalyst decomposes it to steam. Main thrust is provided by the steam through two nozzles directed toward the ground.

Jet deflectors provide thrust for yaw control when the operator needs it. Nozzle positions and exhaust temperatures eliminate the need for protective clothes to shield the operator. ⁂



HURDLING a fire truck is no problem, and 30-ft. hills are just as easy.



GRAHAM navigates a creek with the Army-sponsored feasibility unit.



HILL-CLIMBING with the versatile SRLD saves considerable shoe leather.



Said Isaac Newton:

"Every particle of matter attracts every other particle with a force directly proportional to the product of their masses and inversely proportional to the square of the distances between them."

Until recently, the thrust which propelled rocket vehicles into their coast stage, prior to orbiting, was provided by booster stages. The fuel carried by the satellite stage was used only to inject itself into orbit.

Now, however, a scientist at Lockheed Missiles and Space Division has evolved a Dual Burning Propulsion System which allows higher orbits and heavier payloads. With this system, the satellite vehicle fires immediately after the last booster stage burns out, thus augmenting the begin-coast speed. Later the satellite stage is re-started to provide orbit injection.

An even more recent development by Lockheed is a triple-burning satellite stage. This will permit a precise 24-hour equatorial orbit, even though the vehicle is launched a considerable distance from the equator.

These principles have made possible the early development of the MIDAS satellite. Moreover, they substantially increase the altitude and payload of the DISCOVERER series. Lockheed, Systems Manager for these programs and for the POLARIS FBM, is pursuing even more advanced research and development projects. As a result, there are ever-widening opportunities for creative engineers and scientists in their chosen fields.

Why not investigate future possibilities at Lockheed? Write Research and Development Staff, Dept. M-15A, 962 West El Camino Real, Sunnyvale, Calif. U.S. citizenship or existing Department of Defense industrial security clearance required.

All qualified applicants will receive consideration for employment without regard to race, creed, color or national origin.

Lockheed / **MISSILES AND SPACE DIVISION**

Systems Manager for the Navy POLARIS FBM and the Air Force AGENA Satellite in the DISCOVERER and MIDAS Programs

SUNNYVALE, PALO ALTO, VAN NUYS, SANTA CRUZ, SANTA MARIA, CALIFORNIA • CAPE CANAVERAL, FLORIDA • HAWAII

Technical Countdown

ELECTRONICS

Star Atlas Under Study

Eastman Kodak is "building" under Army contract an infrared star atlas for space navigation. Using highly sensitive IR sensors and the 69-in. reflector at Ohio University, researchers already have obtained stellar data in the middle wavelength range of the IR spectrum. New equipment under construction will record far IR with larger telescopes. The first phase—charting only known stars—will be completed in six months. "Cold" stars will be sought in later studies.

Computers Being Further Minified

A space computer using functional solid-state circuitry is being developed by Westinghouse Air Arm Division. Such molecular units will be employed, Air Arm says, to perform most of the electronic operations—switching, amplification, and other logic functions. A unit will weigh under 15 lbs. and occupy less than 0.33 cu. ft—well over a 10:1 size-weight reduction.

Satellites to Test Electronic Components

Project *Relay*, as a side mission, will explore the technological problems of active electronic systems operating for long periods in space. Of special interest is the effect of radiation on the components of such systems. Life history of components in the *Relay* communications satellites will be measured both by overall performance and by individual characteristics of a number of selected critical units.

SUPPORT EQUIPMENT

Cross-country Computer Link Converted to Tape

Conversion to magnetic tape has doubled the capacity of Douglas Aircraft's transcontinental data transmission system. The tape-to-tape system—which can handle 300 characters per second over telephone lines—connects an IBM 1401 computer at Charlotte, N.C., with a 7090 at Culver City, Calif. The 2200-mile high-speed data link provides the Charlotte plant with direct access to the big 7090 computer, to solve problems in design and development of *Nike* missiles.

3-D Display in Development

The Air Force is funding development of a unique three-dimensional display for possible application in manned weapon systems. The contractor, ITT, has already demonstrated a model of a company-sponsored volumetric 3-D display which can be viewed from all sides and above without the use of special stereoscopic eyeglasses.

Dean Space Drive Hits Air Pocket

The controversial Dean Space Drive which purportedly changes rotational energy into a unidirectional force without the drawbacks of external reactions underwent an analysis last month under an Air Force contract (see p. 24). Contractors' conclusion: The Dean Drive will never get off the ground.

ADVANCED MATERIALS

Laser Metalworking Successful

Lasers have been used by scientists at Trion Instruments, Inc., to punch holes in razor blade compositions and foil. The device also offers promise in the field of microspectroscopy, since the high-intensity beam vaporizes all materials in microseconds. Non-destructive analysis operations would be possible on the production line. The firm is working on a continuously operating laser for such applications.

Electron-Beam Strip Annealing Developed

Temescal Metallurgical Corp. has developed a continuous-annealing furnace which uses electron-beam heating in high vacuum. The strip passes through the furnace, unwinding and rewinding in air at each end. The furnace will have broad applications in processing reactive metals such as tantalum, columbium, titanium and zirconium.

Filament-wound Cases Cheaper

Missile and rocket-motor cases of fiberglass and wire filaments would cost 60% less to manufacture than metallic cases of comparable size, according to a study by Aerospace Corp. Engineers there also pointed out that solid-propellant vehicles currently under development now outnumber liquid systems.

Needed for further development, the report said, are improved methods of creating uniform strength in fiberglass and wire filaments and new advancements in filament-winding technology. Further study of plastic and metal laminates as potential motor case material is recommended, but all design and stress problems encountered must be thoroughly tested under actual service conditions.

New Process for Pershing

Martin Co. has developed an inexpensive technique for protection of the *Pershing* nose cone, requiring no new tooling or facilities. The ablative insulation composition and manufacturing methods were not disclosed, but it is known that the technique reduces weight.

Beryllium from U.S. Ores

A joint agreement between Beryllium Corp. and United Technical Industries will lead to fabrication of beryllium metal from domestic ores. Initially, the firms will operate a plant nearing completion in Delta, Utah, drawing from UTI's holdings in the Spors-Topaz Mountain area.

Material Toughness to be Doubled?

Material strengths as high as 500,000 psi—double that available today—may be achieved within the next decade, a NASA expert has predicted. One of the primary problems being researched: how to attain the desired toughness without an accompanying brittleness.

Continuous-Action Viscosimeter

The Russians have perfected a continuous-action viscosimeter based on the principle that viscosity is determined by measuring the attenuation of natural oscillations of a magnetostrictive probe immersed in the liquid. The instrument permits automatic and remote measurement of liquids, both at rest and during flow.

Consultant's Report Overrides Dea

Model analysis carried out for Air Force finds machine depends on rigid reference, qualifies only as inferior impact or vibration unit

by William Beller

AN AIR FORCE consulting engineer is raising a question whether the controversial Dean Space Drive—a mechanical anomaly which would amend one of Newton's laws—will ever get off the ground.

The drive is described by its inventor as one in which "energy . . . is converted into force capable of acting in any given direction on a given load without reaction occurring exterior to the system or load . . ."

If it worked, the machine could provide a means of vertical motion without ground support.

But an analysis of a model provided the AF Office of Scientific Research says it isn't so. In a report to OSR, Rabinow Engineering Co., Washington, D.C., says the "machine can move weights only when there is a rigid reference to provide the reaction necessary for the operation of the machine."

Norman L. Dean, the Washington inventor of the Space Drive, has been trying to interest the military and industry in the device for more than a year (M/R, May 1, p. 24). He has succeeded in baffling almost everyone who looked at a working model. No one up to now would say for certain whether it would or would not work.

Finally, OSR this April handed the problem over to Rabinow for a solution. Late last month, Jacob Rabinow, principal investigator and inventor of the electromagnetic clutch concluded that:

—The system does not have any unusual properties nor does it contradict Newtonian laws of mechanics.

—The system may have application as an impact machine or vibrator but can not produce a unidirectional impulse without an equal and opposite impulse. However, the device tested is not an efficient design for an impact or vibration machine.

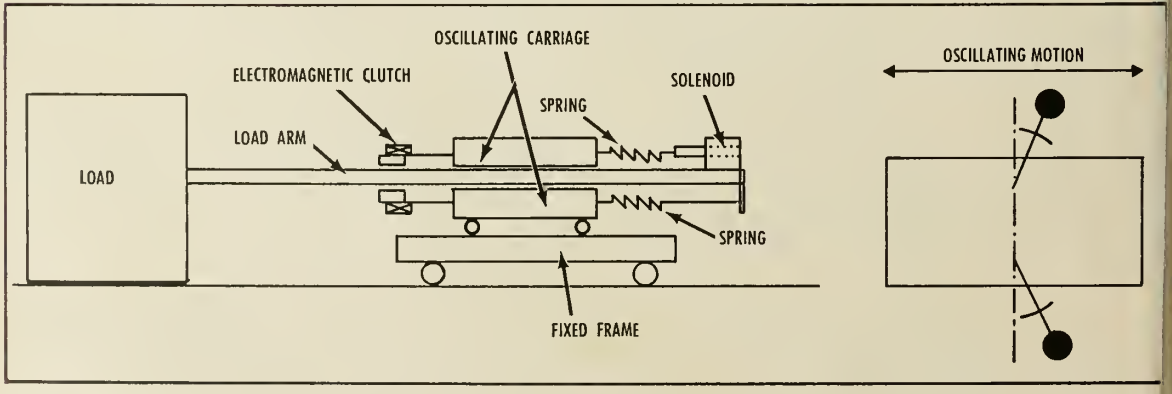
—The demonstration device gives the illusion of generating a force without an equal and opposite reaction by making use of the static friction of the load against the floor—or other support —to absorb the reaction. It cannot perform as claimed in the absence of static friction on an outside reference body.

—There is no way in which the principle employed in the device can be adapted to provide a "space drive." The U.S. patent—No. 2,886,976—awarded to Dean shows a straightforward oscillating mechanism which can produce unidirectional motion only when associated with a stationary reference body.

Queried by M/R on these conclusions, Dean insisted that Rabinow's analysis was not correctly made.

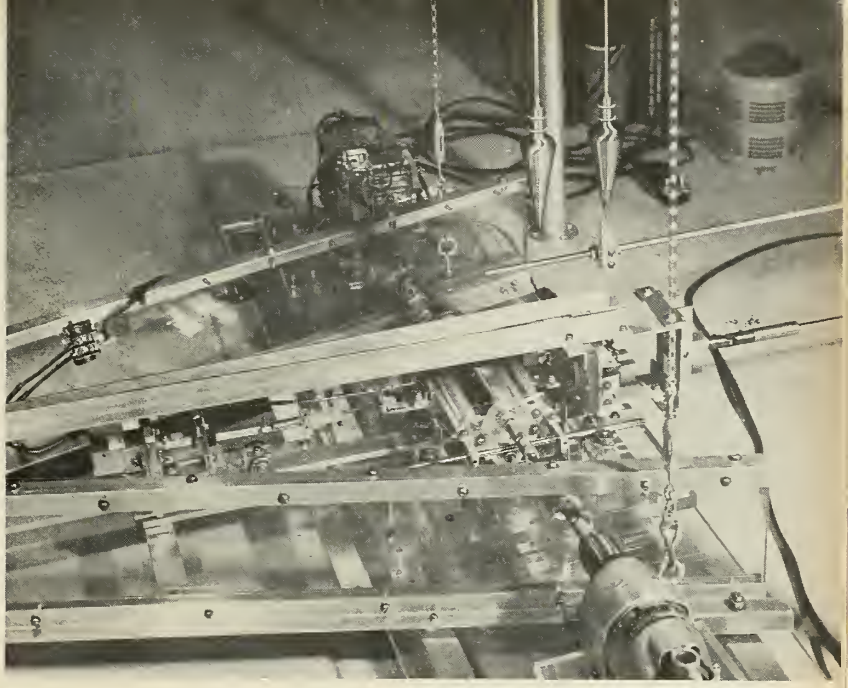
• **How it works**—The model D[illegible] supplied has five essential components: an oscillating carriage, a load and connecting arm, means for coupling the load arm to the oscillating carriage, two electric motors geared together to act as one, and a fixed frame.

Oscillating carriage. Constrained to



LEFT: Schematic diagram of Dean's demonstration model. RIGHT: Schematic of the oscillating carriage.

Space Drive



MODEL OF DEAN DRIVE is suspended pendulum-fashion from an overhead truss.

move only a short distance back and forth along the load-arm axis, the oscillating carriage contains two equal and counter-rotating eccentric masses. These put forces into the carriage which are always co-linear with the load arm. This is done by gearing the masses together so that the load arm is the masses' axis of symmetry.

In the Dean model, the eccentrics weigh about ½ lb. each and have a mass unbalance of ¼-in.-lb. each, Rabinow reports. The carriage, complete with eccentrics, weighs about three pounds. Total movement of the carriage, including travel, is limited by stops to a little over an inch.

Load and arm. The load and connecting arm are said to act essentially as one body. The load arm is described as a rigid member mounted on ball bearings on the fixed frame. It can have a free displacement of about 1½ in. with respect to the oscillating carriage.

Coupling. The oscillating carriage is coupled to the load arm by three separate means: electromagnetic clutch, solenoid-operated spring bias, and a fixed spring bias.

Once every cycle, the clutch and the solenoid are separately energized. The clutch grasps the load arm when the eccentric weights are rotating on the far side of the load. They exert a force on the carriage which—through the clutch—pulls the load. Rabinow says that the clutch tested was able to transmit up to ten pounds of force without slipping.

The solenoid, which has a stroke of 5/16 in., acts for only a short time and applies a spring bias which tends to push the load and the carriage apart. On the other hand, the fixed spring bias applies a smaller force but over a longer period.

The magnitudes of spring biases depend on the relative positions of load arm and oscillating carriage. Rabinow says that the free lengths of both springs are such that they are uncoupled at extreme separation between load and carriage.

Drive mechanism. The eccentric masses are driven by two electric motors coupled together. Sliding universal joints transmit the torque from the motors to the oscillating carriage without interfering with its motion.

Fixed frame. The fixed frame is the base for the oscillating carriage, load arm and drive motors. For demonstration, it is suspended as a pendulum from an overhead truss. Rabinow observes that since the frame is coupled to the load and carriage only through low-friction bearings and a flexible drive, it is not part of the dynamic system.

• **Exterior reactions shown**—Rabinow ran several tests with the model. In the first ones, he attempted to show operating principles and the "apparent" violation of Newton's third law.

Here are the conditions described: pendulum suspension, fixed frame horizontal; external load consisting of a 19-lb. block of aluminum supported on a level, stationary aluminum base-plate; static friction between load and base-plate, 5 to 6 lbs.; moving friction, between 3 and 4 lbs.

In operation, the load is said to be drawn toward the unit in a series of step-wise motions. "Meanwhile," Rabinow observes, "the (fixed frame) and contents, suspended as a pendulum, remain undisplaced from (the) vertical position.

"During the first few cycles the (carriage) moves toward the load until a point of stable operation is reached. Thereafter, the mean position of the (carriage) follows the motion of the load until the motion is limited by the (carriage) hitting the fixed stops."

In the second test, the friction be-

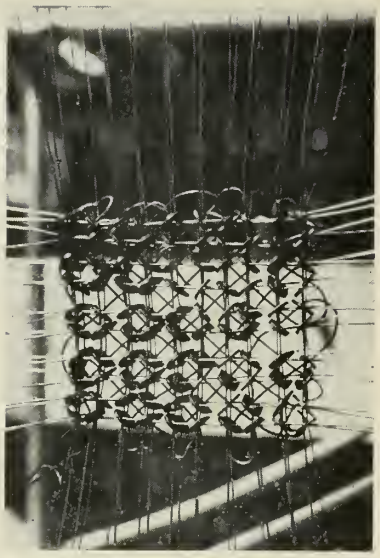
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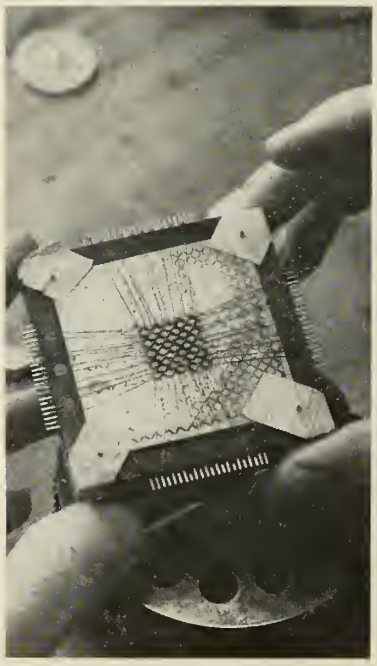
STRAIN ON LOAD BAR causes this Force vs. Time oscillogram. Fact that negative area is approximately equal to positive area shows that momentum is conserved.

IBM Turns Out Record Storage Unit For OAO

by Charles D. LaFond







TOP: *A close-up of an experimental configuration of one MARS plane under construction. Two days are now required for hand-wiring each plane. By November, the operation will be automatic and each machine will do the task in two hours.*

CENTER: *Tiny ferrite cores such as these will be the key memory elements in a new satellite for command and primary storage. Where conventional core memories erase electronically by reading, these unique two-hole cores can be interrogated over and over without destroying information stored in them.*

BOTTOM: *NASA's Orbiting Astronomical Observatory will use the newly developed non-destructive ferrite core as the heart of the data storage and processing system being developed for the satellite. Here, being assembled into 64x64 core planes for preliminary test at IBM's Space Guidance Center, Owego, N.Y., are the tiny MARS devices.*

OWEGO, N.Y. — A breakthrough has been made in spaceborne data memories with development of a nonrotating, nondestructive readout, random-access storage device.

The lightweight, low-power system is dependent upon tiny multi-aperture reluctance switches employed as memory elements.

Currently under development by International Business Machines Corporation's Space Guidance Center here, the device will find first use in NASA's Orbiting Astronomical Observatory *(OAO)*.

This is the massive spacecraft carrying telescopes and a super precise stabilization system which will be built by Grumman Aircraft Engineering Corp. for launch in late 1963 or early 1964.

IBM's high-speed unit is believed to be the largest random access memory of its kind and involves three years of work. Highly advanced redundancy techniques will be used to insure against failure during the satellite's year-long operational period.

• **New memory element**—Curt Johnson, general manager of IBM's Space Guidance Center, says the development represents the "interim storage element before bionics" takes a foothold in tomorrow's information handling systems.

Called MARS (for Multi-Aperture Reluctance Switch), the basic element is a substantially improved transfluxor-type device.

In studying a phenomenon known as inner-wall reflex switching, and other switching mechanisms common to multi-apertured ferromagnetic devices, scientists at the Center discovered a control technique they call "inner-wall pulse bias." This, they said, provided the supplementary control variable which led to the final development of MARS.

Mechanically, MARS is characterized by two small apertures having about the same inner perimeter. IBM felt it was necessary to eliminate the need for a large aperture—which typifies the classic transfluxor—before a practical three-dimensional coincident current, non-destructive readout memory could be developed.

The new element has these attributes plus:

—Half-select currents required for the read and control operations are of equal magnitude.

—Speed capabilities for read and store modes are at least equal to that for a 3-dimensional toroidal-core memory element.

—Unusually small size permits matrix densities of a minimum of 3000 bits per cubic inch.

—Reproducibility and handling offer no obstacles to future use.

• **MARS assembly**—IBM assembles the elements in 4-inch-square planes, each handling 4096 bits. Twenty-five of these can then be stacked to provide a complete 4-wire MARS matrix array. The result is a storage unit providing a 3-D Random Access Non-Destructive Advanced Memory (called RANDAM). It can be instrumented with no more selection or driving means than already required by a conventional 3-D toroidal core matrix. A complete 4-inch-cube assembly has a 102,400-bit capacity.

• **OAO application**—Culmination of the early design work came with the award of the subcontract for a data processing and storage system by Grumman for its *OAO* satellite program.

The work began last Dec. 1 and developmental portions of the system are already undergoing test operation.

RANDAM appears to fit all the unique requirements of *OAO*.

• **OAO instrumentation**—The supporting electronics, stabilization, and control subsystem for *OAO* represent a sizable portion of the payload.

In addition to the experimental packages, command receivers and transmitting equipment, the system will employ a highly complex hybrid stabilization and control system. The electronic link connecting all of these major subsystems is IBM's data storage and processing system.

Under a recently announced subcontract to Grumman, General Electric's Missile and Space Vehicle Department in Philadelphia will develop the stabilization and control for the spacecraft. It will employ coarse and fine control subsystems. Initial alignment will be with a set of large (coarse) inertial flywheels and gas reaction jets for 3-axis maneuvers and hold. Inputs will be from solar sensors and by ground command.

This first alignment will be to a pointing accuracy of within ±1 minute of arc.

The secondary control system will be designed to permit fine angle adjustment to within 20 seconds of arc. To achieve this, six precision star trackers will be used—one at each end of the vehicle and one on each of four sides. Pairs of these star trackers will be oriented to provide corrections for each gimbal angle.

A second set of reaction wheels will be used—one wheel at a time—to gently slew the craft into the desired position. The reaction wheels will be under the control of the star trackers in all but one of NASA's experiments. (The whole system, reportedly, will include a capability for telescope resolution to within 0.1 second of arc. Details on how this will be accomplished are not now available, although some form of radio-inertial guidance and control actuation may be employed.)

• **Data processing**—The IBM memory and data processing will provide readout of observed data or status information at rates up to 100 bits per millisecond. Readout, using the new multi-aperture ferrite core memory, will be provided to the ground at bit rates of either 16 kc or 1 kc.

More than 200,000 data bits can be transmitted to ground in about 7.5 seconds. Since readout is nondestructive, content of the entire memory can be transmitted repeatedly during the time that line-of-sight contact exists. or for up to roughly 10 min.

The memory capacity of the new system is believed to be the largest of its type known to be under development for space use.

The same capacity could be achieved, said IBM, with other devices such as magnetic drums or tape. However, these are rotating devices whose motion would disturb the vehicle's position accuracy.

Other existing non-rotating memories, capable of similar repetitive data transmission, would require prohibitive space. weight, and power-consuming equipment.

The data processing subsystem will consist of five principal units: the command decoder and distributor, the programer, the system clock, command storage, and the delay line logic.

The first serves as the prime input link, verifies and decodes radio ground commands, and redirects radioed and stored commands as required.

Command storage, also non-destructive, holds data received from ground stations for upcoming operations.

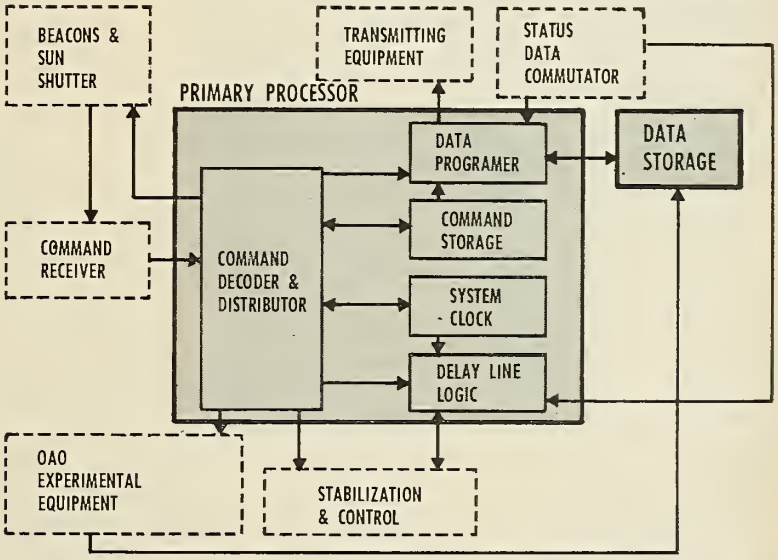
The data programer collects digital data and prepares it for main memory storage. These data later will be telemetered to the ground.

• **Multiple redundancy**—A timing generator and time-compare logic in the system clock provide output signals to sequence stored commands from the associated command memory unit.

Digital control to the stabilization and control subsystems will be provided by the delay line logic.

In the main data storage unit, capacity in flight will depend on memory degradation. Initially, the entire 204,800 non-redundant bits may be used for storage.

With time there will be failures, and the package may be switched to result in a 102,400-bit (redundant) memory. Storage rate is from 0 to 2.5 million bits/sec. for 25 binary-bit parallel input.



HIGHLY SIMPLIFIED block diagram shows how IBM's Primary Processor and Data Storage serve as connecting link for all of OAO's electronic subsystems.

The whole system employs quadruple component redundancy and triple modular redundancy. Importantly, while system provides nearly quadruple overall redundancy, fabrication will result only in 1.5 times increase in weight. IBM says the total system weight of 130 lbs. represents a 4:1 decrease over other comparable systems. due primarily to the packaging techniques employed.

System power requirements are estimated at about 30 watts average with a peak requirement of 59 watts. Power savings are effected, since only those units required for operation are energized at any given time.

To help assure continued operation for the full year of planned use, mean-time-between-failure design goal of 0.89 has been set. System models now under test (8000 hours so far) have indicated a reliability of at least 0.875. ❖



LIGHT-WEIGHT UNCOOLED ROCKET NOZZLE

This drawing is representative of advanced material systems application in high-performance solid rocket nozzles.

1 TUNGSTEN LINER resists 5000-6000°F flame temperatures and high mass flow erosion forces.

2 DIFFUSION BARRIER, stable carbide interface, prevents diffusion of carbon into tungsten and eliminates gas pockets between liner and heat sink.

3 GRAPHITE HEAT SINK provides rapid absorption of heat from liner into graphite. Shape is a function of application requirements.

4 CERAMIC INSULATOR presents a high-temperature thermal barrie to restrict heat transfer into plastic insulation.

5 PLASTIC INSULATION serves the dual purpose of preventing ove heating of outer wall and adds rigidity to the system.

6 FLANGE AND SPLINE ASSEMBLY of high-strength alloy provide axial load distribution and allows nozzle to be assembled fro the inside out.

7 OUTER SHELL of filament-wound plastic provides maximum eff ciency on strength-density basis.

MARQUARDT—The Qualified Source for Complete Rocket Nozzle Systems

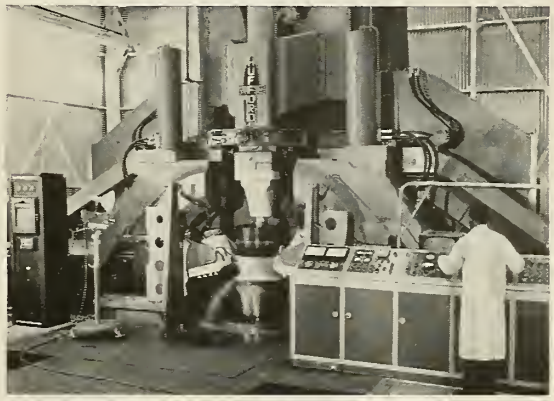
Marquardt's continuing programs of research, development, and fabrication in the ultra-high temperature areas of refractory metals, metal reinforced ceramics, and other composite materials provide a single, complete source for complex rocket nozzle systems. This capability is fully documented by a proven record of materials engineering, processing, and production accomplishments.

Marquardt's unique ability to produce intricate components and systems for the aero-space and defense industries is substantially supported by company sponsored research programs in manufacturing operations. New levels of efficiency and economy in fabricating techniques are tangible results of these programs. Development studies are presently being conducted in high-energy forming of tungsten sheet into radical shapes impractical to form by standard processes; in improving techniques in welding pure tungsten sheet; in producing spin forged tungsten castings and forgings on a high-volume basis.

Significant materials and manufacturing achievements at Marquardt include the development and production of spun tungsten rocket nozzles; a wide variety of nozzle liners and parts; fixed and variable afterburner nozzles; complex attitude propulsion systems and controls; and ramjet nozzles.

Sixteen years of technological experience gained in research, development, and production of a broad range of power systems for atmospheric and space flight are important benefits offered by Marquardt engineers. This leadership combined with extensive facilities provides an exceptional capability for the development and production of reliable high-temperature materials and structures. Detailed information about Marquardt's advanced manufacturing capability may be obtained by writing Corporate Director-Marketing, The Marquardt Corporation, 16555 Saticoy Street, Van Nuys, California.

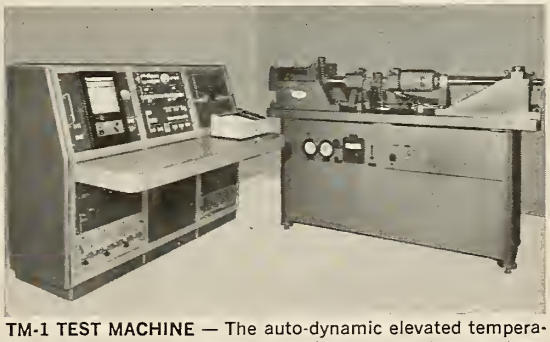
Engineers and scientists experienced in these or related fields will find it rewarding to discuss career futures with Marquardt. All qualified applicants will receive consideration regardless of race, creed, color, or national origin.



SPIN FORGE — Capable of exerting an accurately controlled million pounds working force, this Spin Forge flow forms seamless components up to 5 ft. in diameter and 15 ft. long.



EXPLOSIVE FORMING — This process makes possible the volume production of heretofore impractical-to-form shapes with tolerances difficult to attain with conventional methods.



TM-1 TEST MACHINE — The auto-dynamic elevated temperature test machine conducts tensile, creep, stress-rupture, compression tests of metals at temperatures up to 5000°F. Programming of mission load-temperature-time parameters may be performed.

THE Marquardt CORPORATION

CORPORATE OFFICES, VAN NUYS, CALIFORNIA

ASTRO ◆ OGDEN DIVISION
◆ POMONA DIVISION
◆ POWER SYSTEMS DIVISION

The 'Brain' of the Polaris Missile

Guidance package designed by MIT lab is smallest of inertial systems in present operational missiles

by R. B. Walter

Inertial Guidance Mechanical Engineer, Ordnance Department, General Electric Company, Pittsfield, Mass.



MK I POLARIS inertial guidance system. Shown with the system are the heads of the original design team from Massachusetts Institute of Technology's Instrumentation Laboratory, Ralph Ragan (left) and David Hoag. The same group is now developing the Mk II system for the 2500-mile-range Polaris A-3.

THE *POLARIS* inertial guidance system—only one small component in the Navy's complex Fleet Ballistic Missile Weapon System—plays an immensely vital role in the system's ability to deliver deadly payloads to targets from 300 to 1200 nautical miles away.

Designed (and conceived) by the Instrumentation Laboratory of Massachusetts Institute of Technology, improved versions of the guidance package are already in operational missiles (*A-1*) on station. Further improvements will be reflected in units now being developed for the 1600-mile-range *A-2* FBM.

A redesigned version incorporating the latest state-of-the-art techniques also is in R&D now for the future 2500-mile *Polaris A-3*.

With all the improvements, however, new systems will still be evolutionary embodiments of the present system.

This smallest of all inertial guidance packages used today in operational ballistic missiles was built by the Ordnance Department of the General Electric Company, Pittsfield, Mass.

Designed for launch from submarines well below the sea's surface, the missile is a two-stage, solid-propellant IRBM. After thrust termination of the second stage, the path of the nuclear warhead is a simple ballistic trajectory.

The inertial guidance system is in full control of the second stage up to separation; thus all of its work is accomplished in something less than 60 seconds. First stage up to termination is controlled by an autopilot only.

Within the missile's equipment section, located between the payload and the second-stage propulsion unit, is the guidance system—a stable platform and computer, which, together with the autopilot and programer, guides and controls the missile during the first and second stages of flight. The guidance equipment, contained completely within the missile, has no dependence on the launching vehicle (submarine) after firing.

Using extremely precise gyroscopes, accelerometers and the missile-borne electronic computer, the guidance system puts the missile on correct course at the time of the launch. Should the missile be moved off course by high winds or other effects, the guidance system automatically computes a new correct course and puts the missile on it.

The guidance system also maintains the stability of the missile in pitch, yaw and roll planes. At the precise instant required, the guidance system shuts off the rocket motors and triggers separation of the re-entry body from the missile, The re-entry body then follows a ballistic trajectory to the target.

The guidance subsystem is composed of an Inertial Reference Unit and a computer. The IRU consists of a stable platform and platform electronics, including the servo amplifiers. The digital computer is housed in an electronics unit. The servo amplifiers and power supplies are physically packaged with the computer.

• **Inertial reference**—The primary function of the Inertial Reference Unit is to provide a stable three-axis reference for three accelerometers. A secondary function is to provide attitude reference information to the flight control subsystem. The IRU employs three gimbals, and its inertial components are mounted on the innermost gimbal, or stable member.

The principle of inertial navigation is conventional: the measurement of acceleration by means of a linear accelerometer, integrating once to obtain velocity and again to obtain distance. In the *Polaris* guidance application, velocity signals are required by the computer. The accelerometers are stabilized to local horizontal and vertical before launch, on a gyro-controlled platform. The gyros and accelerometers remain fixed in this orientation in inertial space during flight.

The stabilization of the inner gimbal is provided by gimbal servos, using the gyros to detect any motion of the inner gimbal about any axis and the servos to restore the gimbal to its original position.

• **Inertial components**—The gyros used are inertial rate-integrating, single-axis, floated models. Although exact figures are still classified, drift rate of the gyros is very small.

The accelerometer used is also designed around a gyroscopic principle: that the precession rate of a gyro is directly proportional to applied torque. In the case of the pendulous integrating gyro accelerometer (PIGA) the torque

s provided by a known fixed unbalance of the float about the gyro output axis and the acceleration to be measured. The angular rate at which the accelerometer revolves about its output axis is directly proportional to acceleration along the input axis.

The gimbal servo amplifiers and the PIGA servo amplifiers, plus the necessary servo and platform power supplies and excitation voltage sources, comprise the platform electronics.

• **Computer control**—The *Polaris* inertial guidance system uses a digital computer. Primary function of the missile-borne computer is to accept the velocity outputs of the three PIGA's, combine these with quantities set in by the submarine's Fire Control System before launch, and compute the necessary command signals to insure that the missile hits target within a specified accuracy. These output signals are the thrust termination command, a pitch-steering command, a lateral-steering command, and a pre-arm command.

• **Pre-launch inputs**—Before missile launch, the guidance system depends on the Fire Control System for platform alignment, erection, trajectory coefficients, velocity information, and firing bearing.

The launching of a guided ballistic missile from a ship or submarine to a selected target requires precise determination of the geographical launching position, true north, the ship's linear and angular velocities, earth's rate, and local vertical. These are provided by the SINS (Ship's Inertial Navigation System)—basically a 5-gimballed, gyro-stabilized, inertial-navigation platform with suitable electronic and electromechanical gear for performing the necessary integrations and computations. The SINS is aided, in its accuracy, by systems for periodically checking the position of the ship with respect to shore stations, celestial trackers, and monitoring systems to check the calibration of SINS gyros and detect malfunctions. (For details of the SINS, refer to M/R, July 25, 1960, p. 24.)

Fire Control performs the many tasks necessary to prepare the missile guidance system for the moment of launch. It is itself a complex computer, a memory system, and a check-out device. It performs 6 major functions:

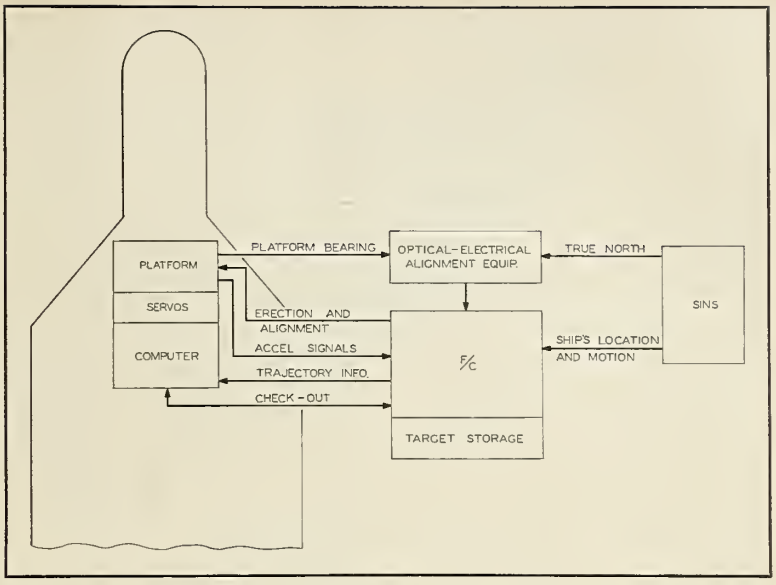
(1) Calculates geo-ballistic trajectories from target information stored within its memory and all the elements of launch point information supplied by the SINS.

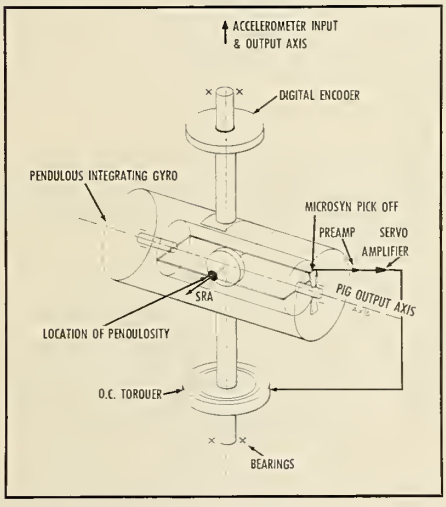
(2) Factors in the PIGA scale factor variations.

(3) Transmits trajectory coefficients and final velocity information to the missile computer.

(4) Computes accelerations at the

(Continued on page 53)

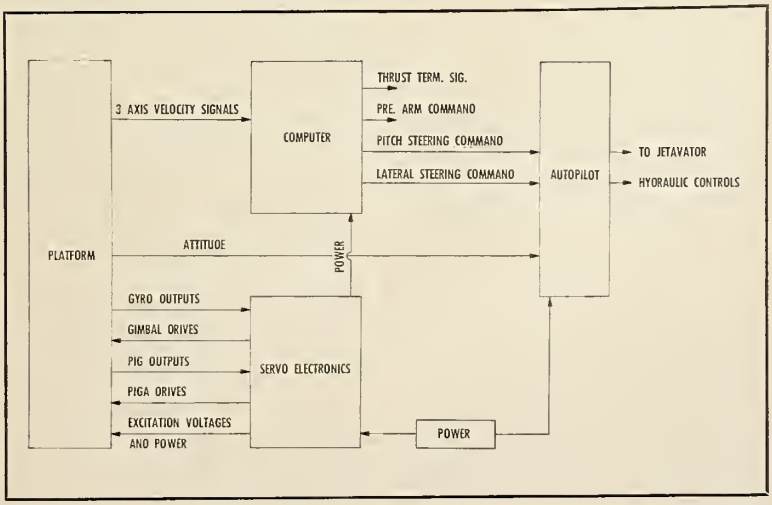




ABOVE: *Pre-launch information flow between Polaris guidance and the submarine support equipment is shown in this highly simplified block diagram.*

LEFT: *PIGA—Pendulous Integrating Gyro Accelerometer—typical of the type used in the Polaris inertial guidance platform.*

BELOW: *Major subsystems of the missile-borne inertial guidance and control systems.*





TANG MARK III is latest in Cannon Electric series developed in company-funded two-year project.

support equipment

Umbilical Connector Exceeds Demand

Cannon Electric reports its Tang Mark III, with rugged and versatile collet-type lock, has passed 60-g test, taken huge acceleration

PHOENIX, ARIZ.—A radically new umbilical connector developed by the Phoenix Division of Cannon Electric Co. has surpassed the performance requirements of the Air Force's *Titan II* program, the company reports.

Most significant of these requirements is a 60-g endurance-type vibration test, applied to make sure that the connector will operate while subjected to the acoustical noise and sympathetic vibration conditions typical of silo launching installations. The Cannon device—designated "Tang Mark III"—passed the test on Dec. 15, 1960.

In addition, the company says, the Tang Mark III and its cable, providing signal and power circuits between the ground control equipment and the missile, has withstood acceleration levels never before encountered.

Comprehensive analysis and experimentation made it possible to overcome these mechanical resonances and fatigue conditions. The connector was carefully designed for maximum reliability.

• **A new family**—The Tang Mark III is third in a series of new connectors for umbilical and interstage applications.

The series combines established connector principles with new design features and concepts. It was developed in recognition of the fact that as space research and national defense programs demand larger and more powerful missiles, missile manufacturers will demand more reliable operation—under increasingly stringent environmental conditions.

Anticipating this trend, Cannon Electric Co. inaugurated its own development program two years ago.

The heart of the Tang Mark family is a new collet-type lock dubbed the "Tang Lock." This unit has been incorporated in various central lock and peripheral lock combinations. It is readily adapted to various releasing means such as manual lanyard, electric solenoid, pneumatic and explosive squib.

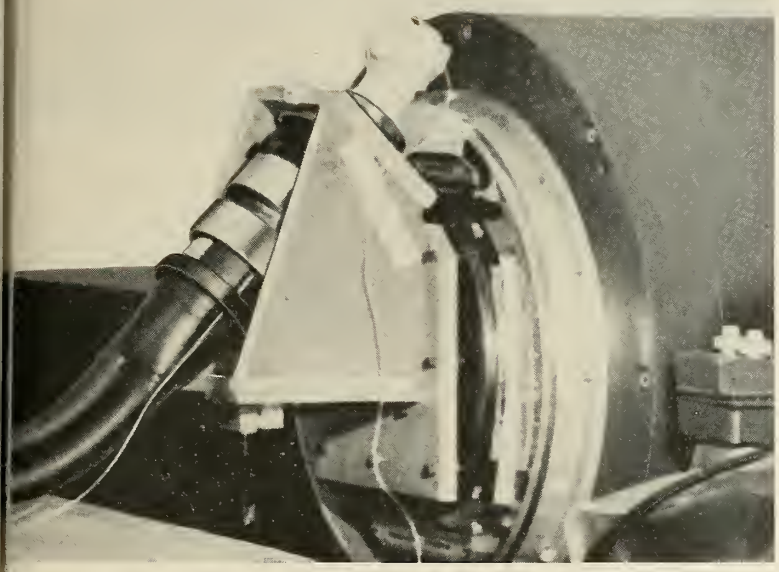
The flexible and efficient locking device will hold a plug and receptacle together in their mated conditions with thousands of pounds of force, and yet effect instant electrical separation and ejection with the application of a low specified force. For example, one design with a mating force of 6000 lbs. is released by a force of only 25 lbs.

• **60-g vibration problem solved**—Development of the "Tang Lock" is said to be a step forward much needed by the connector industry. This claim is supported by a discussion of some of the unique problems confronted in successful fulfillment of The Martin Co.'s vibration requirement for the *Titan II*.

The Martin sinewave vibration test required a 15-minute sweep from 5 cps to 2000 cps to 5 cps in each of three mutually perpendicular axes. During this test, a sweep rate of approximately one octave per minute was maintained; a constant excursion of 0.25 in. double amplitude was held between 5 and 66 cps and constant acceleration of 60 g's was held between 66 and 2000 cps.

An umbilical cable weighing 600 lbs. was terminated to the plug. This mass, combined with that of the 18-lb. plug, was supported by the receptacle—weighing only 4 lbs.

So severe was this test that neoprene-



UMBILICAL CONNECTOR, here undergoing test, is mated to Titan II at angle of approximately 45°.

f Titan II Program

molded rubber in the proximity smoked from the generated frictional heat. Despite the combined high temperature and vibration, all electrical circuits maintained electrical continuity and passed Martin specifications by an easy margin of 5 to 1.

In addition to the sinusoidal endurance test, a resonant frequency survey was required. This consisted of a sweep through each of the three mutually perpendicular axes at 0.4 in. double amplitude from 5 to 12 cps and 10 g's peak from 12 to 2000 cps, during which time resonant frequencies were recorded. This was followed by a 35-g dwell for three minutes at each of the detected resonant frequencies.

Most outstanding result of this test was that the Tang Mark III had no significant resonances. The largest amplification factor recorded was 1.5.

Many other factors influenced solution of the vibration problem. One of the most meaningful was the fuel immersion requirement.

The *Titan II* uses a liquid fuel—Aerozine 50—and an oxidizer—Nitrogen Tetroxide, both of which are highly corrosive. Materials had to be selected carefully for greatest corrosion resistance. Unfortunately, the few usable materials are not optimum for structural purposes, and it was necessary to design around this deficiency.

• **Salient features**—The Tang Mark III would not have been possible without detailed study of future ICBM requirements and careful selection of development objectives. The product itself evolved out of a single, closely controlled project for *Titan II*, and can best be described by an account of its more salient features.

Operation of the unit is simple. Engagement is achieved by rotating a coupling ring on the plug body; a standard strap wrench is the only required tool. Disengagement is manual, effected by applying 150 lbs. force to the lanyard.

Fundamental to the connector design is its two-stage lock-release operation. In ejecting from the receptacle, the plug retracts all electrical connections before breaking a seal and mechanically disengaging. This prevents cocking or jamming during during release and excludes explosive mixtures from the circuit-breaking area.

The static strength of the Tang Mark III is 40 tons, which represents a structural safety factor of 10 when compared with peak dynamic forces. The peripheral-type lock is evenly distributed around the circumference of the connector, insuring optimum symmetry and mechanical stability.

Dynamics is a critical consideration with umbilical connectors because of their "series" relationship within the missile-ground control complex.

The environment of such umbilicals is greatly influenced by the missile engine, which is started and brought to full thrust before the umbilical disconnects. When the launch is made from an underground silo, this environment becomes even more hostile.

Having ten structural members and two basic moving parts, the Tang Mark III has employed three techniques to insure positive electrical continuity during engagement and to prevent prerelease (ejection of the plug before deliberate force has been applied to the release lanyard).

The first technique involves resonance compensation, wherein resonant frequencies are eliminated or self-compensated. This calls for control of the rigidity of structural members and resonance contributing parts.

The second technique utilizes vibration damping; even the individual parts are afforded this luxury. These resonances not eliminated by basic designs are either reduced in magnitude or changed to a frequency where their effect is less deleterious. Throughout the Tang Mark III, resilient materials are used in various ways to absorb energy.

The third technique uses a system of interlocks guaranteeing that the high mass of various parts cannot cause prerelease. The connector only releases when a steady force is applied directly by the lanyard. Thus, the forces developed in vibration, although extreme in magnitude, are incapable of effecting release.

Utilization of these three methods has resulted in a design that the company says is mechanically simple and offers a new high standard of reliabiliy.

The Phoenix Division of Cannon Electric Co. has been awarded its first order for the new connector by The Martin Co., marking the beginning of a new era for the connector industry. ⌗

Big Buy by Martin

The Martin Co. will use four Tang Mark III umbilicol connectors per Titon II, with each umbilicol containing 228 connector pins. The connector mates with the missile at on angle of opproximotely 45 degrees. Connon Electric Co. soys the umbilicol connector could cost os much os $2500, depending on vorious production circumstonces. The Tang Mark III possed oll its environmental tests in December. Connon believes it is the only connector in the industry to withstond o 60-g vibrotion foctor.

Propellant Loading System Cuts Dow

Trans-Sonics' Equibar, built around pair of glass discs, is example of differential pressure gage type

by John F. Judge

ONE OF THE KEYS to optimum vehicle performance in current and future liquid rockets is accurate control of propellant loading—and in-flight propellant utilization.

Since most of the take-off weight of large liquid systems is propellant, the value of instrumentation which avoids the burden of an unusable percentage of fuel is obvious.

Upwards of 10,000 gallons of fuel and oxidizers are pumped aboard large vehicles in a very few minutes and to an accuracy of about 0.2%. The physical and chemical properties of the fluids compound the problem. And the necessity to hold a missile in stand-by condition for some time adds the requirement of an automatic topping system.

One propellant loading system currently used in a large development program is the Equibar, developed by Trans-Sonics, Inc., Burlington, Mass. The Equibar system is of the differential pressure gage type.

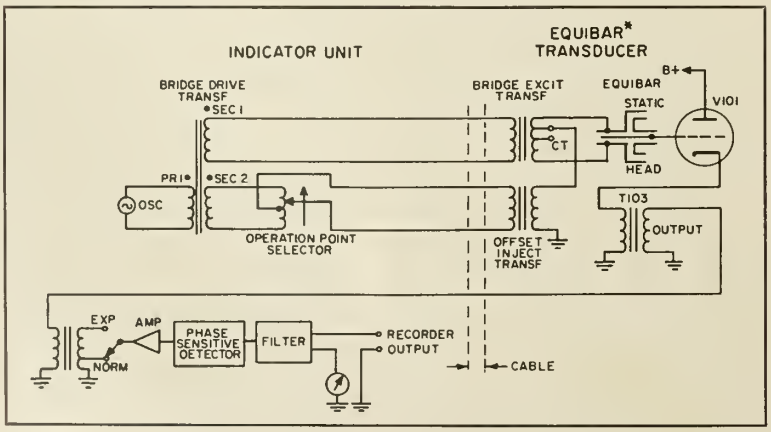
The loading system will indicate when a tank has been loaded to a preset value of a propellant mass. Mass values, which may range from 50-100% of actual tank capacity, may be remotely set into the system.

Indication is made continuously as a percentage of the preset mass value. During the initial loading operation, the system will indicate between 0-110% of the preset value.

The system has a d-c output, the value and polarity of which is proportional to the difference between the actual and preset loading value. The output may be used either for recording or to actuate a pump, valve or other control element.

• **Vital component**—The essence of the Equibar is a pair of similar glass discs, each with a shallow spherical cavity. The two discs in juxtaposition are separated by a metal membrane. A metal coating on the surface of each cavity provides an electrode. The two electrodes and the membrane comprise an electrostatic potentiometer.

Electrical output is obtained by using the potentiometer as half of a bridge, the other half being either a resistive potentiometer or an appropriately tapped transformer winding. Depending on the application, the frequency of the excitation signal applied to the bridge may be a few hundred or a few thousand cycles. The reference spring is the metal membrane held under large radial tension. Deflection of the membrane is approximately linearly proportional to the differential pressure.



SIMPLIFIED SCHEMATIC of the Equibar propellant loading system. Power supply consists of 115v, 400 cps, single phase to control panel for the entire system.

Tension in the membrane is approximately independent of pressure. Geometry, not strain, establishes an equilibrium position corresponding to an applied pressure. Thus, hysteresis proportional to change in strain is reduced to a negligible value. Instrument designs have been made for full-scale pressure ranges from 0.5 to 15 psi—covering the whole range of differential pressures which obtain for current propellants and tank sizes.

Each Equibar system consists of two differential pressure transducers and one control panel. The transducers are mounted directly in the vehicle while the panel can be located as far as 1500 ft. distant. Both fuel and oxidizer may be loaded simultaneously under the control of the system.

• **General systems**—R. L. Blanchard, A. E. Sherburne of Trans-Sonics and R. E. Scott, consultant, described instrumentation for loading and inflight utilization to the recent National Telemetering Conference.

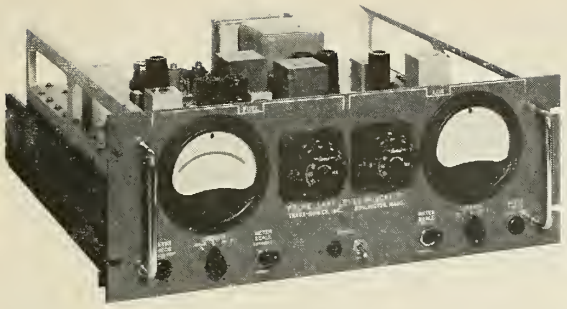
There are several different approaches to the propellant loading problem—volume and density, differential pressure and differential capacitance.

The volume and density method is simply the determination of mass from the product of volume and average density. The procedure provides for loading to a fixed mass or to small variations from a fixed mass of propellant. Accurate level sensors are required and are readily available.

Volume calibration of the tanks, temperature measurement or control of room temperature propellants, and temperature measurement or equilibrium pressure of cryogenic propellants are necessary. A ground-based flow meter for the incremental correction is also necessary, but the accuracy requirements for this flow measurement are not severe.

The measurement of differential pressure is the most direct means for determining total propellant mass. The method requires volume calibration of the tanks, and a differential pressure gauge accurate to about 0.1% and otherwise suitable for the application is

iel Burden





OPERATIONAL system consists of control panel and two transducers, one of which is pictured at right.

ieeded for effective measurement.

Provisions must be made to keep the iquid out of the pressure tap lines to ivoid false pressures due to acceleration or pressure head of such liquid. A small low of helium gas has been used suc- essfully to continuously purge the lines.

The helium bubbling into the liquid propellant causes pressure fluctuations which are made relatively high in fre- quency by using a sufficiently high helium flow rate. The resulting fluctua- ions in the electrical signal are removed by the low-pass filter characteristics of he system.

The temperature differences may be handled automatically for non-tempera- ture controlled fuels such as RP-1 and may be fixed for a cryogen. The density problem is largely accounted for in the method. The differential pressure meth- od is especially suited to the loading problem for either a fixed or variable mass and where both propellants are cryogenic.

Incremental corrections for factors anticipated in a particular flight program are easily incorporated into the system, as is stand-by topping control, since the instrumentation provides a continuous analogue measurement.

• **Differential capacitance**—The dif- ference between the dielectric constants of the liquid and gas phases of a propel- lant leads to a method for continuous analogue measurement of either volume or mass. A capacitor electrode struc- ture extends the full length of the tank.

Below the surface of the liquid, the space between electrodes is filled with the liquid; above that level it consists of gas. By comparing the resultant capa- citance with that of a completely sub- merged capacitor, the height of the fluid in the tank can be measured.

The system can be developed to measure mass in either of two ways. The temperature dependence of density can be used along with temperature transducers in a manner similar to the volume and density method. Or the relationship between dielectric constant and density can be exploited.

The technique hangs on the ability to measure capacitance to great ac- curacy and, considering the problems encountered in missile installation, cabl- ing etc., this is not accomplished with- out thorough engineering.

The method has the advantage that it is a continuous system free from mov- ing parts and the geometry of the tank is accounted for in the geometry of the sensor. But the achievement of high accuracy presents a difficult engineer- ing problem.

• **Flying meters**—The Trans-Sonics experts then considered the in-flight closed loop control problem. The pur- pose of such a system is to permit the vehicle to carry a larger payload or achieve a higher velocity with the same payload.

Without a propellant utilization sys- tem, there is some uncertainty in the propellant burning rate and in the mix- ture ratio. The rocket must be designed to perform its mission in spite of this.

But the addition of such a system represents additional weight. Thus its effect in decreasing the amount of un- used propellant must more than com- pensate for the added weight.

The scientists compared the final velocities of a group of rockets without utilization systems to a similar group with such systems. It turned out that some of the rockets without the system outperformed those with it. This is be- cause the value preassigned to the amount of unused propellant was higher than the actual figure.

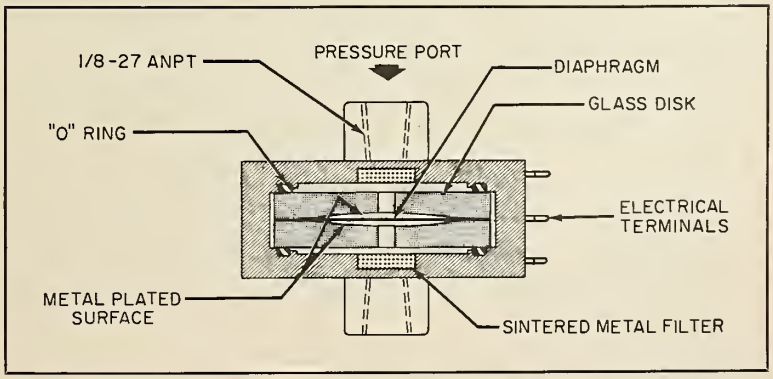
But the comparison also showed that the spread in final velocities is much smaller for the controlled rockets. The effect of the system is to decrease the tolerance on final velocity—thus allow- ing the use of an increased payload in a corresponding amount.

In-flight utilization system can be either continuous or discrete point sys- tems; both are capable of high per- formance. The design of an in-flight system is similar to the loading sys- tems. The major difference is that the absolute quantity of propellant is of primary interest in the loading system, while it is only of secondary importance in the utilization system.

The in-flight system has the primary purpose of causing a minimum of residual propellant at shutdown, with the restriction that the mixture ratio must not vary beyond certain limits.

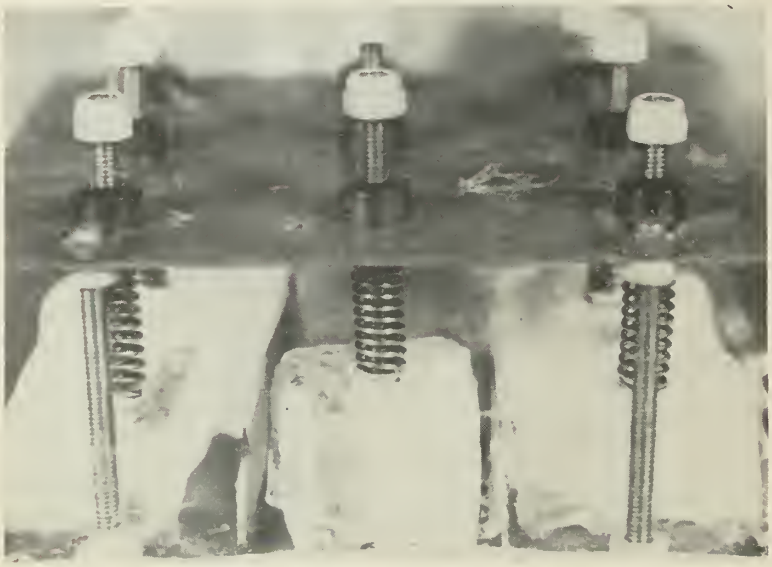
The Trans-Sonics experts conclude that differential pressure, point level sensors temperature measurements, fluid calibration and differential capacitance are the most suitable techniques for pro- pellant loading where one or more of the propellants is cryogenic.

In-flight utilization control promises significant advantages but also presents a complex system problem. Only one mis- sile has used such a system to date. ⌘

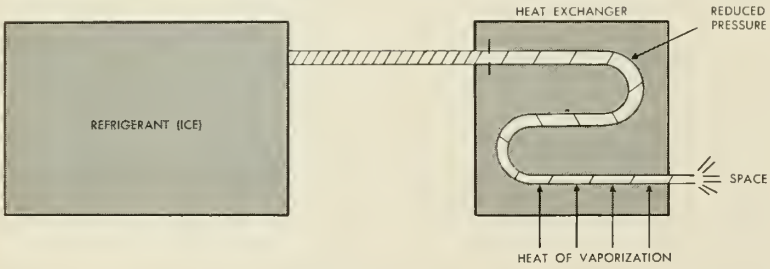


PRESSURE TRANSDUCER in system has already been used in experimental manned rocket aircraft as pitch and yaw control element. Diagram outlines operation.

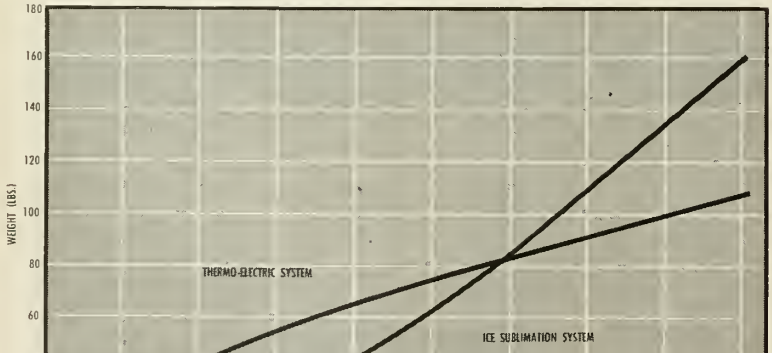
'Ice Box' Best for Short Space Trips



CHEAPEST SPACE REFRIGERATOR, sublimated ice cubes do well in lab tests.



GENERAL ELECTRIC CONCEPT is simple. Space vacuum obviates power source.



EXPENDABLE NATURE of system makes it feasible for only about 20 man-days, during which it compares very favorably with thermo-electric refrigeration. GE figures base weight for food and containers (20 days) in both systems to be about 100 lbs.

GE finds system converting plain ice into vapor may be simplest and most efficient refrigeration method

PHILADELPHIA—In a time of sophisticated Space Age engineering, technical breakthroughs and weird new devices, one company has come up with a refreshing old concept.

General Electric, long experienced in the appliance field, was given the task of developing some new refrigerating techniques for space vehicles under a $50,000 contract with Aeronautical Systems Division, AFSC (then ARDC).

GE's long experience in refrigeration would lead one to expect something rather advanced. Not so, says GE's Missile and Space Vehicle Department. In fact, for trips of about two weeks, the best way to keep food from spoiling probably is to carry along a cake of ice.

But GE's ice-box will have little resemblance to its predecessors except in componentry. While grandma's ice-box had a capability only of the relatively low heat of fusion (144 BTU's/lb.), GE's Space Age refrigerator has a heat absorption capability of 1220 BTU's per lb. of ice.

In the GE concept, the ice is converted directly into vapor rather than water by keeping it under a pressure not greater than .020 psi. In flight, the space vacuum would be used. This sublimation not only makes it a more efficient refrigerant, it eliminates the problem of liquid-vapor separation in the absence of gravity.

Laboratory tests prove out the idea. As shown in the diagram, the process is extremely simple. Ice cubes were used during testing to provide large surface areas and short thermal paths. Under pressure, the ice cubes were barely affected after hours of use.

As shown in the bottom chart, ice would be impractical for a trip of longer than about 20 man-days. Under Project *FROST*, GE has also studied various methods of keeping food for trips of several months and several years.

"A thermo-electric refrigeration system appears to be too costly in terms of power required," says Sid Halpert, *FROST's* project engineer. The system which affords the greatest promise for long journeys, he says, is a direct radiation system using space as a heat sink. This part of the program is still under evaluation.

'Exotic' Communications of Small Use

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Areas studied and conclusions reached by the Martin study:

- **Ultramicrowave**—A fundamental breakthrough in generation techniques is needed to make this region useful. There is no practical method for generation of radiation in the 300-3000 gc range in excess of one milliwatt.
- **Infrared**—The development of infrared lasers may provide a method for obtaining useful amounts of coherent radiation. Conventional methods of generating IR radiation, however, involve a degree of incoherence which make it unsuitable for communications. Filtering for monochromatism and attempting to increase power densities—which requires an increase in temperature and shifts the power peak frequency—both reduce power efficiencies an energy source to power more efficient radio generators.
- **Deflected sunlight**—An elaborate heliograph, even though of limited range and channel capacity, would provide a practical communication method. The sun's light energy—although a noisy, incoherent source—is free, and total radiation is high. Energy intensity is very low; a large portion of the visible spectrum would be required for long-range transmission.
- **Particle systems**—Since free space would produce negligible scattering of a beam of particles, such beams, modulated to carry information, appear attractive for many reasons. Charged particles, however, are affected by magnetic fields; such a system would not be practical in the vicinity of earth or any other planet with an appreciable mag-

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'Ice Box' Best for Short Space Trips

GE finds system converting



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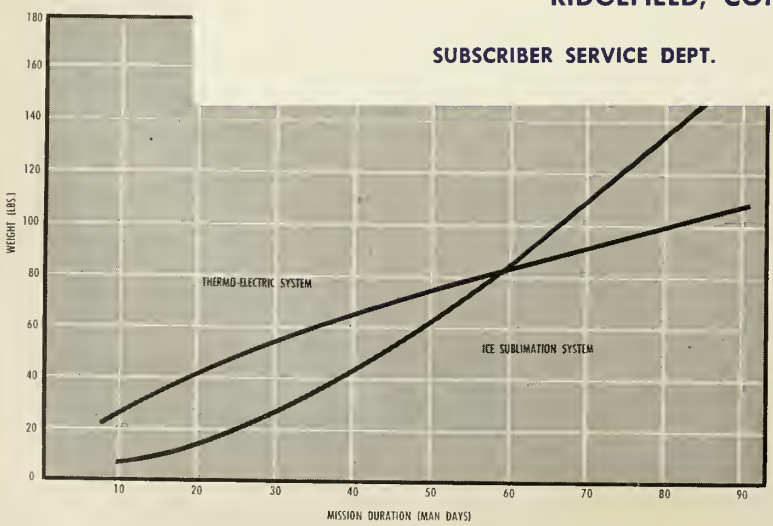
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'Exotic' Communications of Small Use

Martin engineer finds that laser and deflected sunlight are only approaches in exotic region which appear to have practical value—even practical methods seem sure to be restricted to visible light

CHICAGO—The laser and deflected sunlight may hold the only practical potential in the way of "exotic" communications.

This is the finding of a Martin Co. engineer, L. R. Bittman, in a paper presented to GlobeCom V during the National Telemetering Conference.

Bittman's study was prompted by the mounting problem of spectrum-crowding of conventional radio-frequency communication and the coming need for communications ranges of astronomical distances in space exploration.

Areas considered in the study included ultra-microwave, infrared, visible light, ultraviolet, X-ray and gamma rays. The use of deflected sunlight, elementary particles, and even mail rockets was also studied.

Bittman said the exotic region—so named because conventional methods of radiation generation do not apply—begins at an arbitrary boundary of about 60 gigacycles (kmc). His evaluation showed that very few of the exotic methods studied would be practical. Quantum energy considerations would make them undesirable for communication purposes even if such methods were to be developed.

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• **Visible light**—Recent laser developments point to a future visible-light communication system. Radiation is coherent and power densities extremely high. Estimated intensities per unit wavelength are one million times that of the sun.

• **Ultraviolet** — Several techniques have been recently proposed for use of UV in space communications. One method, using exploded wire, produces a power density peak in the UV region and looks feasible for transmission over astronomical distances. Power conversion efficiency is quite low, however. *(Ed. note: Westinghouse scientists recently developed a UV generator they say is capable of transmission ranges of 50 million miles with a radiated power of one watt.)*

• **X-ray and gamma-ray**—X-radiation is largely incoherent, consisting of band spectra with superimposed monochromatic peaks. The radiation cannot be focused and power conversion efficiency is very low.

Gamma radiation, although proposed as a direct means of communication, appears to offer more potential as an energy source to power more efficient radio generators.

• **Deflected sunlight**—An elaborate heliograph, even though of limited range and channel capacity, would provide a practical communication method. The sun's light energy—although a noisy, incoherent source—is free, and total radiation is high. Energy intensity is very low; a large portion of the visible spectrum would be required for long-range transmission.

• **Particle systems**—Since free space would produce negligible scattering of a beam of particles, such beams, modulated to carry information, appear attractive for many reasons. Charged particles, however, are affected by magnetic fields; such a system would not be practical in the vicinity of earth or any other planet with an appreciable magnetic field. Also, calculations show that the maximum attainable range would be in the order of tens of thousands of miles, rather than the millions of miles required for a practical deep space communication system.

As for a neutral atom particle system, only very-low-power efficiencies can be foreseen. In addition, there remains the question of what happens to the beam when the neutral atoms are photoionized by the sun's Lyman-alpha radiation.

The only real justification for exotic system development, according to Bittman, is the need for a communications link from outer space back to earth. Already overcrowded terrestrial links cannot tolerate the additional interference contributed by space-to-earth radio transmissions.

The radio-spectrum for space-space communications, Bittman says, has no allocation problems—and is not likely to have in the near future. Therefore, conventional methods will suffice.

The argument for exotic methods on the basis of narrower beamwidths—and resulting greater antenna gains—was torn down by Bittman. He said that beyond the submillimeter band it would be impossible to aim such narrow beams with any probability of their detection by a receiving antenna. In the visible light region, the tracking problem would be so severe that the beam would have to be enlarged to secure a communications link, thereby losing any advantage gained.

Conclusions reached by the Martin study showed that even if a practical exotic method were to be developed. it almost certainly would be restricted to operation in the visible light region—since this is the only portion of the spectrum possessing a transparent window in the earth's atmosphere. Consequently, since the need exists only for a system capable of operating within or through the atmosphere, only the laser and deflected sunlight offer promise as communications links. ⁂

Ignorant Test Techniques Deplored

LOS ANGELES—A leading industry executive has charged there is an "appalling" lack of knowledge of how nondestructive testing techniques can aid the U.S. missile and space vehicle program—and that this ignorance extends through every echelon of government and industry.

Kermit A. Skeie, Director of the Materials Testing Laboratories of Magnaflux Corporation, said agencies responsible for hardware design can call out exact testing techniques to assure ultimate performance, but too often require tests which will meet an arbitrary specification without assuring that the component will ever fulfill its purpose.

At a recent meeting on non-destructive testing, he said "when military specifications allow a manufacturer will use the cheapest, simplest—and often least effective—test method available. This is intended to satisfy military specification requirements, but gives no indication of the component's soundness or ability to do its job. The aim, of course, is to save time and money . . . both of which are lost ultimately anyway."

Richard P. Turner, Western Regional Manager for Magnaflux, advocated that specifications place greater emphasis on nondestructive testing, with sufficient leeway for choosing the best test method, regardless of its type.

"We can't test the materials and components of 1961 with the test attitudes of 1941," he said, "and many companies are trying to do just that. They have a World-War-Two-type inspector at the end of a line who sees that the part is within its dimensional tolerances; then they X-ray it . . . maybe . . . and presume that nothing else can be done."

"Despite the qualifications of most engineers within their own fields," he continued, "it is amazing how many seem to feel that nothing escapes an X-ray and that no other test method can possible compare in effectiveness. We once had a minor component design come to our attention that was to be tested by exposure to 22 X-rays from different angles. A component like this often doesn't need 22 X-rays . . . it needs redesign."

• **Few and unconsulted**—Skeie said he knows of no college or university presently teaching test engineering. Most test engineers, he said, are converts from other engineering areas.

Our present system, he said, rarely incorporates test engineers in basic hardware design phases. A prime question, Skeie argued, should always be: "Can we adequately test this thing to be sure it will work?" But since fully qualified test engineers are seldom invited at this stage, the question isn't asked. Later in the program, major reworking is needed because the part won't work.

He recalled one unnamed missile program in which engineers designed a large tank, to be fitted with a pipe at one end. The final design called for a hole to be drilled, the pipe (unthreaded) to be jammed into the hole and brazed about the surface of the junction.

"They couldn't have designed a better built-in circular crack . . . guaranteed to fail," Skeie commented. The braze passed inspections called for by MIL specs, he added, but didn't perform. "The tank caused a major upset of the missile program's schedule, and the surprising thing is not that the things failed, but that any worked at all."

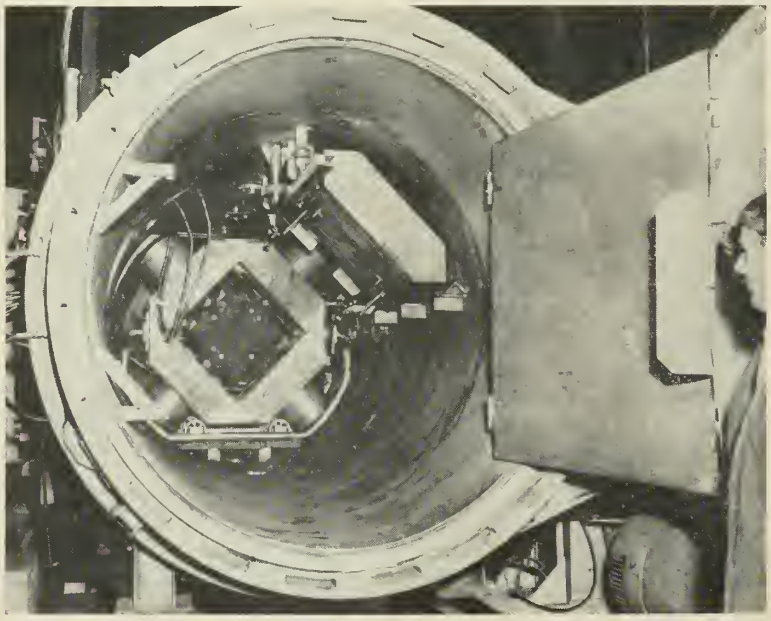
Asked for an estimate of how many fully qualified test engineers are now in industry, Turner placed the figure in the dozens.

Specific recommendations made by the Magnaflux executives were:

1. Introduce adequate testing considerations as early in the design stage as possible, giving more thought to filling missions rather than filling specifications not intended to cover the problem at hand.

2. Allow greater leeway in specifications calling for tests. The amount of time presently required to change specifications sometimes prevents an effective test program being carried out because it fails to fill a spec written several years previously. Test specifications should stress the end use of the item.

3. Provisions should be made for a long-range increase in the number of qualified test personnel, including university courses and greater in-plant utilization of contributions to be made by test engineers. ✱



Testing by Firing

ENVIRONMENTAL TARGET CHAMBER, built by Tenney Engineering Company, will be used to test potential space materials. The 6x18 ft. compartment, built for the Air Force's Arnold Engineering Center, at Tullahoma, Tenn., can simulate air pressure at 75 miles altitude, apply a heat source up to 1500° in two hours, and fire projectiles at undisclosed velocities through an evacuated 10-in. tube extending 30 ft. out of the chamber to a gun arrangement.

Is Defense Advertising Necessary?

There has been a lot of talk lately about the cost of the advertising done by defense contractors. One prominent Senator recently said he was greatly disturbed over heavy defense advertising expenditures. He pegged the cost "to the taxpayer" at $500 million.

This figure is many, many times the actual total of defense advertising expenditures and only a fraction of that total is recoverable. The Senator's facts are wrong; but, even more disturbing, it appears that he doesn't understand the purpose and function of sound advertising. He considers this money down the drain and thinks it should not have been spent.

There are other instances demonstrating a growing wave of anti-advertising sentiment in high government places. They indicate a lack of understanding and represent a threat both to freedom of the press and success of the Nation's defense goals.

We publish specialized business magazines and reference books. Several of these are defense oriented. They perform communications functions essential to our national goals . . . more essential now than ever before because of the complexity of today's technological and political challenges. There are other excellent magazines having the same or similar purposes. We're delighted—because competition is healthy and because there is more to be done than can be handled by any one of us.

Virtually all publications are financed, by and large, by advertising. This is healthy, too; but it is not the primary reason for defense advertising.

We believe that advertising is an effective and necessary tool for the defense contractor. The objectives of defense advertising are many: some of them obvious, others more subtle.

Sales is one obvious objective. It can be demonstrated that advertising, for some defense products, has led directly to sales. In other instances, selling is a long, complex process, where features of current products may not be as important as company reputation. In both cases, the government wants competition for defense contracts—by use of a competitive bidding system, it gets better products for less money. How is a company to compete if it is not allowed the use of sales tools—one of which is advertising?

Recruiting is another obvious objective. Will that engineer who is inspired to contribute to technological advancement in the missile/space age, for example, be interested in learning more about the kind of company he goes to work for? You bet he will, and more power to him.

The dissemination of technical information is a third, and perhaps the most important, objective. The exchange of such information is one of the biggest problems facing both government and industry. And what more effective, more economical means of disseminating necessary technical information exists than the business press? Mills Shepard, who performs readership studies on one of our publications, reports that advertisements are often read as avidly as the editorial pages. And Eastman Research, in a study released May 29, based on more than 100 surveys for 32 business-paper clients over a two-year period, reports that *70% of the readers interviewed read the advertising in these businesspapers on purpose.*

There are many other equally important objectives. Companies must raise capital in order to be able to do the jobs that need doing for defense. Good community and employee relations are considered necessary to a company's well-being. These and other objectives have been effectively achieved by defense contractors through advertising.

The defense industry is made up of numerous private companies facing the tremendous challenge of meeting, in cooperation with the government, our national technological goals. To meet this challenge, the companies must be strong and healthy. To deprive them of the use of effective and honest advertising is shortsighted and wrong.

AMERICAN AVIATION PUBLICATIONS, INC.

World's Largest Aviation Publishers

1001 Vermont Avenue, Northwest, Washington 5, D. C. Telephone: STerling 3-5400

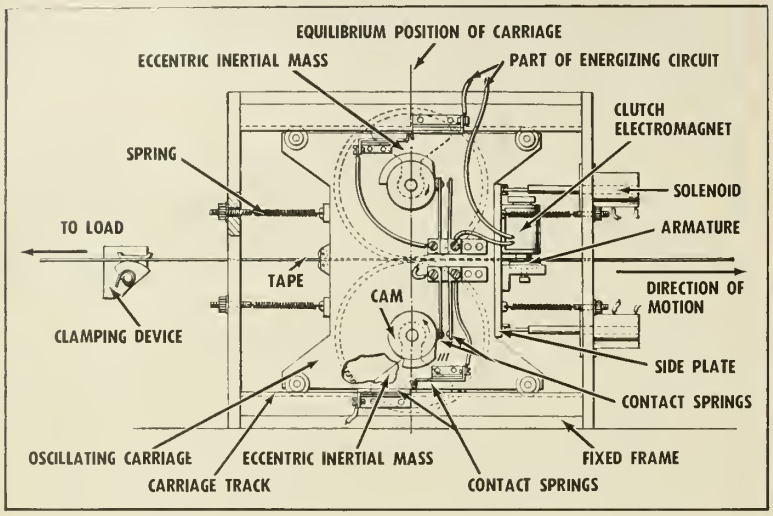
Aviation Daily • Official Airline Guide • Missiles and Rockets • Airlift
Air Traffic News • Who's Who in World Aviation and Astronautics
R. Spruce Company • Home & Garden Supply Merchandiser

EDITORIAL EXCELLENCE

Air Cargo • Skyways • Armed Forces Management • Air Travel
Aerospace Yearbook • Air Traveler's Guide • World Aviation Directory
H & G S M Green Book • Aerospace Facts and Figures

Doubtful View of Dean Space Drive

(Continued from page 25)



SYSTEM PATENTED by Dean for transforming rotary into unidirectional motion.

tween the load and its support was minimized by the use of rollers, the friction forces becoming less than an ounce.

Here are the results: "The load oscillates at the same frequency as the (carriage) but does not advance toward it. If the load support is slightly inclined from the horizontal, the load rolls downhill, the direction and rate of rolling being independent of whether or not the (carriage) is operating."

Rabinow maintains that the focus of interest should be on the carriage and not on the fixed frame—since the frame is, in effect, isolated from both load and carriage.

Consequently, he says, if the frictional forces of the load were smaller than the reverse spring forces, and if the positive and negative impulses were equal, the load would move backward due to the spring force and the net displacement would be zero.

Thus, the second test shows that the machine has no net unidirectional effect on an inertial load if the frictional load is small compared to the mass.

• **Operating criteria**—In another test, Rabinow modified the friction beneath the load by connecting a spring with variable tension between the load and a point behind it.

As a result of this test, it was concluded that "when the resultant of external spring load and internal spring bias is approximately equal to the static friction, the load moves backward during the negative impulse and hence oscillates instead of advancing."

In the last test, wire strain gages were mounted on the load arm. The resulting traces on an oscilloscope were force-time plots. The most important conclusion reached—in view of the current controversy—is that momentum was indeed conserved. Rabinow noted that the area under the positive spikes is equal to the area under the negative portion of the traces. "In other words," he says, "the positive and negative impulses applied to the load are equal."

In general, then, the load moves toward the carriage if:

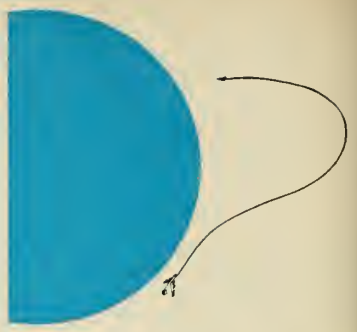
1. The peak force developed during the positive impulse—clutching of carriage to load—is greater than the load's static friction, and

2. If the opposing spring force developed during the remainder of the cycle is less than the static friction.

The phenomenon being exploited by Dean in his demonstration model is nicely illuminated by an example given by Rabinow. He envisions a man on roller skates trying to move a table. He can do it by using his own inertia and pushing in a series of jerks. He needs only to produce short pulses of forces greater than the value of static friction between the table and floor—and he can do this even though he's mounted on perfect wheels.

In fact, Rabinow observes, the portion of the floor on which he rolls could be suspended as a free pendulum to show that he has no reaction on the floor. He would reset himself for the next pulse merely by using the force of the static friction between the table and its base as his anchor.

On the other hand, if the load itself were mounted on perfect bearings, the man and the table would oscillate but neither would go anywhere. ⁂



SKYBOLT



This new USAF weapon now under development will combine the range and mobility of the jet bomber with the speed and the difficult-to-detect capabilities of the ballistic missile. Yet Skybolt's warhead-carrying re-entry vehicle must operate with the same reliability and accuracy of ground-launched re-entry vehicles.

Environmental conditions—The re-entry vehicle must withstand hour after hour of vibration and noise fatigue aboard its bomber "launching pad"—the USAF B-52 and the RAF Vulcan bomber. Its heat protection system must endure repeated thermal cycling from ground take-off temperature to −65° F at cruising altitudes. If launched, it could be exposed to re-entry temperatures of 7500° F.

Extended Life—Skybolt's re-entry vehicle must have a useful life of several years through repeated storage, thermal cycling, and return to storage—all with a minimum amount of maintenance.

The Skybolt missile system is being developed from known and proven engineering principles, resulting in rapid program advancement at great saving to the American taxpayer. The Missile and Space Vehicle Department of General Electric's Defense Electronics Division is developing Skybolt's re-entry vehicle. 160-0

GENERAL ELECTRIC

Circle No. 5 on Subscriber Service Card

MISSILE AND SPACE VEHICLE DEPARTMENT, PHILADELPHIA, PA.

SKYBOLT is being developed to add a new dimension to America's growing missile might. Launched from an airborne B-52, it is being designed to arc through space toward targets more than 1000 miles away. The re-entry vehicles for this advanced USAF missile are being developed by General Electric's Missile and Space Vehicle Department under contract to Douglas Aircraft Company, prime contractor for Skybolt.

GENERAL ELECTRIC



NASA Submits Overhauled Indemnification Legislation

A REVAMPED PROPOSAL allowing NASA to indemnify contractors against unusually hazardous risks in space contracts was given to the House Space Committee by the space agency last week.

The new version, designed to counter objections raised before the Senate Space Committee earlier (M/R, May 22, p. 45), would require firms to obtain all available commercial insurance before becoming eligible for Federal protection. NASA Administrator James E. Webb explained that in this way firms would be protected from ruin without making the agency an insurer where commercial coverage was "reasonably available."

The proposed section resembles the indemnification feature of the Atomic Energy Act which limits government liability to $500 million for any one nuclear catastrophe. Coverage would also extend to subcontractors.

As the agency would amend it, the bill (HR7115) also: (1) calls for remedies provided in state workmen compensation acts to be deducted in evaluating government liability; (2) permits Congress to pass on—through special appropriation—any damage claim exceeding $100,000 and (3) requires NASA to use the facilities and services of private insurance organizations to the maximum extent practical in administering the law. ⌗

mergers & expansions

UNITED NUCLEAR CORPORATION, New York, has acquired the Nuclear Fuels Operation of Olin Mathieson Chemical Corp., the Nuclear Division of Mallinckrodt Chemical Works and the Nuclear Development Corp. of America, through exchange of stock.

GENERAL MILLS has consolidated all activities within the company involving electronics and allied fields, together with two wholly-owned subsidiaries, into the General Mills Electronics Group.

Major facilities will be in Minneapolis, Chicago, Los Angeles, Livingston, N.J., and Manchester, N.H. Personnel of the present Mechanical Division will form the nucleus of the new organization. The division's activities will be taken over by four specialized groups, each operating semi-autonomously as an Electronics Group member-organization.

There will be an Electronic and Mechanical Defense Products Department. Balloon and Aerospace Systems Department, Automatic Handling Equipment Department, and Research Department. Magnaflux Corp., Chicago, and The Daven Company, Livingston, N.J., are the subsidiaries completing the Electronics Group. Richard A. Wilson, corporate vice president, will direct overall operations of the Electronics Group, and will continue as chief executive of both Magnaflux and The Daven Company.

RADIO CORPORATION OF AMERICA has formed two new divisions in its Defense Electronic Products organization. The Major Defense Systems Division, Moorestown, N.J., will be managed by D. Brainerd Holmes, and the Aerospace Communications and Controls Division, Camden, N.J., and Burlington, Mass., by Irving Kessler. Division Vice President and General Manager. Arthur L. Malcarney, DEP Vice President, says of the new departments: "Adjusting to the volatile conditions of national defense requires an underlying philosophy of flexibility. Our changes will concentrate more effectively our capabilities and skills in major defense areas. . . ."

LORAL ELECTRONICS will acquire American Beryllium Company, Inc., and its subsidiary operations, U.S. Beryllium Corp. and Visioneering Corp. Loral's board of directors approved the action and said American Beryllium will operate as an independent, wholly-owned subsidiary of Loral.

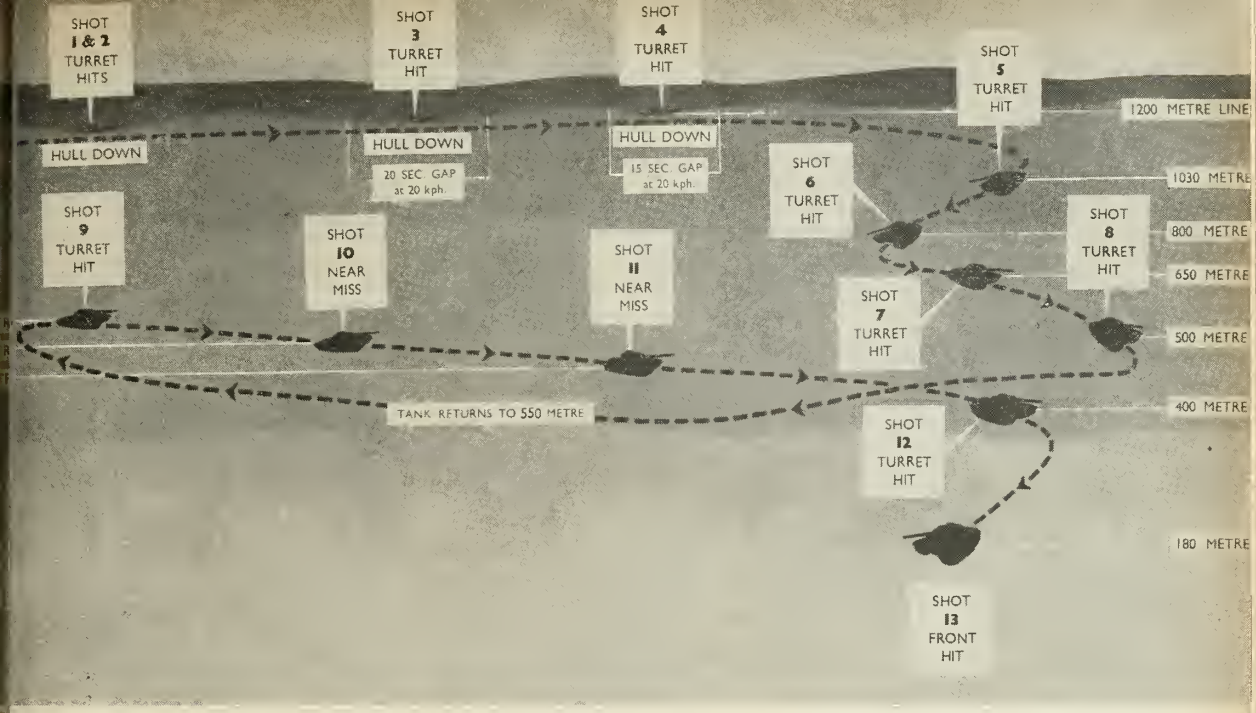
MOTOROLA SEMICONDUCTOR PRODUCTS INC. has opened a 315,000-sq.-ft. addition to its Phoenix manufacturing facility, more than doubling the plant's present size. The Company says its plant is now the second largest single semiconductor production facility in the U.S. It expects to add a "substantial number of additional employes in the next few years. The addition cost some $4.8 million, to which will be added an estimated $2 million worth of manufacturing and research equipment.

THE BARDEN CORPORATION Danbury, Conn., has announced formation of the Barden Research Precision Mechanisms Division to design, manufacture and market precision device

Financial Reports

COMPANY	PERIOD	INCOME		EARNINGS	
		1961	1960	1961	1960
California Eastern Aviation	3 mo. Mar. 31	$ 8,447,819	$ 8,073,999	$ 179,856 ($0.09 per share)	$ —244,431
General Instrument Corp.	Year, Feb. 28	70,644,123	66,895,542	3,424,891 ($1.41 per share)	2,655,652 ($1.23 per share)
Micradat Inc.	3 mo. Mar. 31	1,457,539	756,766	91,537 ($0.21 per share)	46,371 ($0.18 per share)
	6 mo. Mar. 31	2,497,875	1,525,741	164,292	113,681
Matec Industries Inc.	3 mo. Apr. 28	17,081,968	1,262,771	748,340 ($0.77 per share)	981,869 ($1.02 per share)
*Northrop Corp.	9 mo. Apr. 30	196,766,000	170,184,000	6,258,000 ($3.22 per share)	5,313,000 ($2.73 per share)
Atlantic Research Corp.	Year, Dec. 31	(1960) 13,513,889	(1959) 8,315,163	811,689 ($1.01 per share)	438,614 ($0.57 per share)

*Company says sales rise was helped by deliveries of Datica automatic electronic evaluation units for *Polaris* and on-schedule progress of *Skybolt* guidance system.



PATH OF TANK and launching position distances during Vigilant demonstration.

International

Vigilant Scores Kill at –200 Yds.

A Vickers-Armstrong Ltd. *Vigilant* infantry antitank missile recently hit a moving Patton M-46 tank less than 200 yards away—believed to be the shortest-range strike yet demonstrated by such a weapon.

The trials, which took place on a range "somewhere in Europe," were witnessed by senior British and Allied officers. The ranking officer termed the short-range hit "fantastic."

During the tests, the British Aircraft Corp. trials team was asked to engage a moving target as close in as 218 yards. Immediately accepting, the team directed the tank to a 300-meter line and told it to come in along a side road of the range. At what was later discovered to be 200 yds. range, the round was fired.

The 340-mph. *Vigilant* was whipped onto the sight-line in 100 yds., using the 6-g turning power of the weapon's steering flaps. The tank was struck on the lefthand track, just under the turret, while moving at 18 mph on a 10° crossing to the right.

The weapon was put through a series of other tests involving the tank. In one instance, the operator scored two clean hits on the turrent even though it was visible only for a 20-second and a 15-second period.

During the trials, the *Vigilant* ran up a score of 11 hits out of 13 attempts at ranges from 200 to 1300 yds. This includes firings by personnel with brief experience.

The driver of the tank, alerted by radio to each firing, had been able to see the rounds in flight. According to Vickers, experience has shown that a round can be seen if the driver is prealerted and concentrates on the direction of attack.

But it has also been shown that no maneuver, including stopping and backing, has been able to avoid a hit.

Company spokesmen say that the weapon offers a considerable savings in training and training costs. The average infantryman needs only a simulator course plus three or four live rounds to be a competent operator. Trainees have frequently hit six out of six moving targets on their first live firings. ⁂



ANTITANK MISSILE at moment of launch. Its accuracy stems from a twin-gyro autopilot which eliminates weaving flight characteristics of acceleration control.

COMING UP!

The only single source for a complete and comprehensive analysis of world missile/space systems, M/R's 1961 Missile/Space Encyclopedia will include diagrams and descriptions of all U. S. and foreign missiles and spacecraft.

The 5th annual issue of the Missile/Space Encyclopedia will be distributed to **MISSILES AND ROCKETS'** 32,500* paid subscribers—plus a bonus circulation of 7,500 for distribution to top military personnel and to U. S. service academies.

With a total distribution of more than 40,000, M/R's July 17 Missile/Space Encyclopedia issue will thus reach virtually all of the people who direct the activities of the missile/space industry, with the most complete coverage-in-depth of key buying and specifying influences.

*Subject to audit.



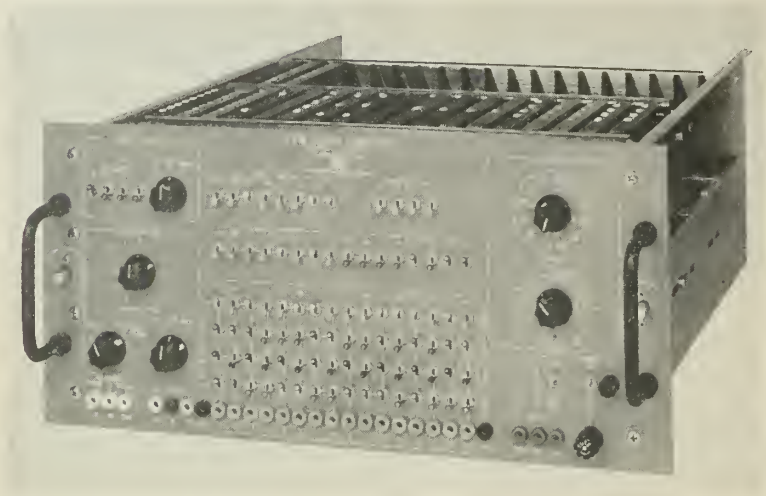


missiles and rockets

5TH ANNUAL MISSILE/SPACE ENCYCLOPEDIA ISSUE

July 17, 1961

Advertising closing date June 26



Signal Simulator for PCM

A signal simulator which provides PCM signals for checkout, calibration or evaluation of PCM telemetry equipment has been developed by Electro-Mechanical Research, Inc. The unit fills the need for a versatile digital instrument which can check out existing PCM equipment and equipment planned for future programs.

By means of front-panel controls, the bit rate may be set in the range of 50 bps to 200,000 bps; the frame length may be set in the range of 1 to 256 words; and word length may be chosen in the range of 1 to 16 bits. Provision is made for an external clock input. The data content of all words can be preselected by front-panel binary-coded switches permitting choice of any word-sunc code, parity code, or data code. The Model 208A provides both series and parallel outputs.

Circle No. 225 on Subscriber Service Card

Miniature Tape Recorder

A miniature magnetic tape recorder which simultaneously records data (1 to 14 channels, in line or interlaced) from tests conducted under severe environmental and extremely limited space conditions, is available from Aero Data Corp., Division of American Concertone, Inc. Model TR-1875 is available in speeds of 1.875, 3.75, 7.5 and 15 in. per second, with a capacity of 150 ft. of 1-mil Polyester Instrumentation tape providing up to 16 minutes recording. This is a small, lightweight, precision-built unit measuring 4¼ in. dia. and 4¾ in. long, weighing less than 3½ lb., complete with full load of tape. The wow and flutter under static conditions is less than 1%.

Circle No. 226 on Subscriber Service Card



Cryogenic Measuring System

A low-temperature cryogenic measuring system has been developed by Texas Instruments, Inc. This system includes a germanium thermometer and a special "servo/riter" potentiometric recorder. The germanium thermometer is available in three versions: calibrated, uncalibrated, and standardized. The thermometer (or cryometer) couples with the special "servo/riter" recorder resulting in a system which accurately obtains low-temperature measurements.

Circle No. 227 on Subscriber Service Card

Miniature DPDT Chopper

A line of unique low-noise DPDT miniature choppers for microvolt instrumentation applications is available from James Electronics Inc. Nine-pin plug-in and flange mount models are available. Frequency response is 1-500 cps at microvolt levels.

Circle No. 228 on Subscriber Service Card

Transient Suppressors

Relcoil Products Corp. is marketing a line of transient suppressors. The TR Series are encapsulated solid-state devices designed to protect electronic circuitry from damage caused by line transients and from transients caused by the switching of inductive current loads. These transients may vary from only a few volts to several thousand volts, and can vary from microseconds to many milliseconds in duration.

Circle No. 229 on Subscriber Service Card

DC Null Voltmeter

Outstanding stability and resolution with 1-millivolt end scale sensitivity, and a floating, high-impedance input are principal features of new Hewlett-Packard Model 413A DC Null Voltmeter. A d-c Null Voltmeter, having 13 zero-centered ranges, running from 1 millivolt to 1000 volts end scale is available from Hewlett Packard Co. High input impedance (10 megohms on the most sensitive range, 200 megohms on the 300 millivolt range and above)



makes this instrument especially valuable in resistance bridge measurements.

The input terminals are isolated from ground, allowing operation up to 500 volts dc or 130 volts ac from ground potential. Accuracy of the unit is within 2% of end scale. Drift and noise are virtually imperceptible.

Circle No. 230 on Subscriber Service Card

Feed-Thru Capacitor Line

Dearborn Electronic Laboratories, Inc. has introduced a line of "clean pass" feed-thru capacitors that are a subminiature-type feed-thru radio interference suppressor. Dimensions range from 0.312 in. O.D. x 5/8 in. long to

in. O.D. x 1-5/16 in. long. The components combine maximum insertion ...s over a broad band of radio frequen...es with minimum size and weight.

Dearborn engineering design of the ...readed neck on the capacitors effec...ely eliminates inductance between ...ise source and output terminals. This ...sign also minimizes contact resistance ... chassis, thus obtaining near-optimum ...sertion loss.

Circle No. 231 on Subscriber Service Card

...lotting Instrument

Numerical control techniques and ...ghly accurate shaft position encoders ...e employed in a point plotter devel...ed for precision layout of templates, ...arts and other work requiring exact ...sitioning and available from Datex ...orp. The instrument employs two ...rvo-driven carriages mounted on the ... and Y rails of a basic Haag-Streit ...achine. Carriage positions are meas...red by two Datex CG-703 Geared ...haft Position Encoders having a reso...ution of 0.001 in. The extreme accu...acy of the encoders permits carriage ...osition determination to five significant ...gures over the entire 47-sq.-in. work...ng area.

Circle No. 232 on Subscriber Service Card

Universal Template

A template for drawing pictures of ...ent-up sheet metal parts of all gauges ...rom .020 thru .090, in any of the four ...uadrants and with bend radii from .03 ...o .25 is available from Barto Co. Draw...ngs of sheet metal parts are made more ...uickly and more accurately with this ...emplate than is possible by the old-...ashioned hand method of measuring ...he thickness with a scale and then try...ng to draw the inside bend radius and ...he outside bend radius with a circle ...emplate or compass .

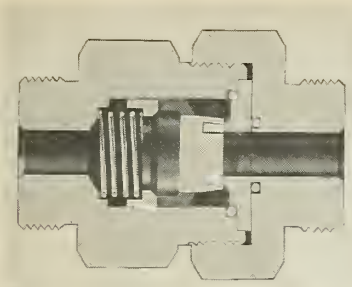
In addition to its use in drawing ...ormed sheet metal parts, the Universal ...Template can be used as a gauge to ...ndicate the thickness of flat sheet-...metal parts.

Circle No. 233 on Subscriber Service Card

O-Seal Valve Ends

Combining the radical concepts of a soft-seated valve and O-ring fitted connections and unions, a CPV O-seal system which gives proven leakproof flexibility for handling liquids and gases at pressures to 6000 psi is available from the Combination Pump Valve Co. The heart of the O-seal valve is the resilient nylon disc which deforms and perfectly assumes the surface of metal seat, assuring positive valve shut-off.

Even the eroding effects of high-pressure, high-velocity gases do not affect bubble-tight valve closure at pressures in excess of the rated 6000 psi.



A Teflon thrust washer and O-ring stem seals eliminate the need for valve packings, a potential source of leakage and a constant maintenance headache.

Circle No. 234 on Subscriber Service Card

Phenolic Resins

Two phenolic resins developed to withstand exposure to high temperatures encountered by missiles and space vehicles are available from Reichhold Chemicals, Inc. One, designated Plyophen 23-017, is a phenolic silicone resin superior to the straight phenolic resins and to the epoxy-modified resins for exposure to high temperatures for fairly long periods of time. The other, Plyophen 23-057, is a polyamid-modified phenolic resin developed especially to withstand ablation and burn-through resistance when the material is exposed for short periods of time to temperatures in excess of 6000°F.

Circle No. 235 on Subscriber Service Card

A-C Coupling Card

Computer Logic Corp. is marketing a plug-in logic coupler card, Model AC-1. The solid-state coupling card is compatible with the 200 kc series of digital logic circuit modules.

Circle No. 236 on Subscriber Service Card

Frequency Meter

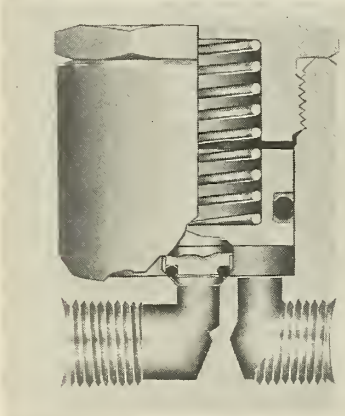
A series AFM Automatic Frequency Meter available from Somerset Radiation Lab. Inc. satisfies the general-purpose frequency measuring and monitoring requirements for a simple, fully automatic but economical instrument that can be used in conjunction with commonly-available microwave instruments for continuously monitoring microwave frequencies. The AFM indicator employs a sensitive, aircraft-type, dual-meter movement that permits reading frequency directly and unambiguously at the intersection of one pointer, whose position is a function of frequency and power level, with another pointer, whose position is solely a function of power level.



Circle No. 237 on Subscriber Service Card

Priority Valve

Complete isolation of any portion of hydraulic or pneumatic systems below a preset point is available in a line of priority relief valves from Circle Seal Products Co. The P-458 Priority Relief Valve, operating at pressures to 2000 psi, is externally referenced, with actuation accomplished by absolute system pressure rather than differential pressure between inlet and outlet. Fail-safe valve closure is effected by positive spring pressure whenever downstream pressure drops below design closing pressure.



Circle No. 238 on Subscriber Service Card

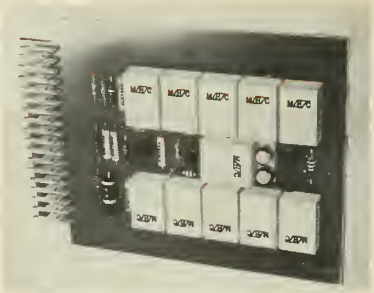
Liquid Lathe

A liquid lathe for cutting materials is available from Abrasi-Jet Machine Tool Corp. The liquid lathe, a machine which resembles a cannon, delivers a needle point of liquid under thousands of pounds of pressure capable of cutting through cement, wood and tough plastic. An immediate practical market for the concept was found in the safe removal of high-energy solid-propellant materials from engine casings. Models for cutting and shaping metals and other materials are under development.

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Magnetic Shift Register

The Magnetics Research Co. has available a multidirectional shift register. Information is taken in and out of the 10-bit register in series or in parallel. The direction of information transfer can be changed in between shift pulses.



Information can be transferred from register to register on command. As a shift-right, shift-left 10-bit unit, it has wide application as a reversible preset decade counter with outputs available for each unit of the count. Input information can be gated into the register under control of the flipflop, and use can be made of this feature to directly encode punch card information into magnetic tape code.

Circle No. 240 on Subscriber Service Card

Adjustable Resistors

Ohmite Mfg. Co. is furnishing the complete range of adjustable resistor sizes and resistances to meet the "C" revision of MIL-R-19365. The adjustable resistors are constructed in the same fashion as Ohmite fixed, power resistors. Resistance wire is wound on a high-quality ceramic core and covered with a high-quality vitreous enamel. On the Dividohm-type resistor, however, a bared strip of resistance wire is left exposed for tapping by means of one or more adjustable lugs.

Circle No. 241 on Subscriber Service Card

Vertical Sensing Element

Kearfott Division has available the C70 1808 000 vertical sensing element, a single-axis, proportional low-cross coupling error, damped, bubble type, electrolytic unit. Its sensitivity is virtually unaffected by sustained cross accelerations up to 1 g, and it can withstand more vibration in the low-frequency high-amplitude range than any other unit of its type currently available.

Circle No. 242 on Subscriber Service Card

Directional Couplers

Waveline, Inc., has designed miniature 6 db waveguide directional couplers with excellent coupling characteristics over a broad band frequency range.

These directional couplers combine small physical size with a minimum of coupling variation over a large portion of the waveguide frequency range.

Special designs may be generated for miniature couplers with coupling values from 5 to 10 db. These special designs will adequately cover a 12% bandwidth of frequency range with a maximum coupling variation of ±0.5 db.



Circle No. 243 on Subscriber Service Card

Portable Ripple Meter

A Model T256 Ripple Meter specifically designed to measure ripple voltage on aircraft and missile d-c power supplies is available from Atron Manufacturing, Inc. The T256 can also be used as a battery or line-powered, transistorized volt-meter. Its sensing method can easily be set to "peak to peak," "plus peaks," "minus peaks" or "RMS,"



so that one instrument can check a variety of specifications and read quantities that can't be easily measured on an oscilloscope. A large meter with color-coded scales simplifies reading.

Circle No. 244 on Subscriber Service Card

Alumina Ceramics

Diamonite Products Mfg. Co. has facilities available for volume production of high-alumina ceramic parts and components for production metalizing. Metalizing may be performed using the moly-manganese, titanium hydride reactive metal or any other suitable processes to which the metal can be brazed. If desired, the metalized section can be plated prior and subsequent to the brazed assembly.

Circle No. 245 on Subscriber Service Card

Silicon DC Power Supplies

A line of silicon d-c power supplies for virtually every industrial application requiring d-c power has been announced by General Electric's Low Voltage Switchgear Department. Available in ratings from 0.75 kw to 75 kw, the line is divided into three basic industrial rectifier groups consisting of general purpose units, essential service units and synchronous motor field excitation units.

Circle No. 246 on Subscriber Service Card

new literature

THERMOSTATS—A four-page bulletin describing a line of commercial types A and AY snap-acting, fixed-temperature thermostats is available from Stevens Mfg. Co. The four-page technical data bulletin describes the various models comprising the line, gives information on available terminals, mountings, etc. Ranges, ratings, differentials also are covered.

Circle No. 200 on Subscriber Service Card

GLASS DATA—Expanded data on corrosion resistance and thermal expansion of 32 commercial glasses are major additions to a revised booklet published by Corning Glass Works. The average expansion coefficient from room temperature to the setting point of the 32 glasses is given for use in sealing applications. A new numerical code system shows the resistance of each glass to weather, water and acid.

Circle No. 201 on Subscriber Service Card

BUSHINGS—Adjustable Bushing Co. has published a 32-page pamphlet quickly describing the product and typical usage of adjustable wall-thickness bushings and associated Adjusto-Fit products. The pamphlet (No. 60A) is illustrated with line drawings showing how cylindrical fits are obtained in bolting structural joints, clevix and hinge pins, rod end bearing pins, bearing and seal applications, etc.

Circle No. 202 on Subscriber Service Card

AUTOMATIC COIL WINDING—An 8-page brochure on the technique of fully automatic coil winding is available from Industrial Winding Machinery Corp. This pamphlet describes the operation of Aumann Model WPA coil-winding machine which can be equipped for semi- or fully automatic winding of field coils, bobbins, voice coils, armatures, etc.

Circle No. 203 on Subscriber Service Card

ELECTRONIC TRAINING—A 32-page brochure titled "How to Train Electronics Personnel" has just been published by the Cleveland Institute of Electronics. Created to outline the potentials offered through home study of the Electronics field, the booklet's contents are directed to industrial employers, utilities, government officials, commanders of military units and educators. The brochure discusses the growing requirements for trained people in this fast-growing field and the upgrading of those already in it, as well as the techniques used by the Cleveland Institute and the home study educational group generally in fulfilling these needs. The booklet also contains a comprehensive catalog section describing in detail the technical courses offered by the institute.

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names in the news



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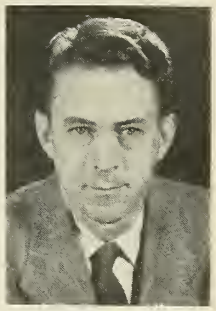
GUARINO



VOLKERS



BAILEY



GOSS

Robert E. Lewis: Former president of Sylvania Electric Products, Inc., joins Perkin-Elmer Corp., Norwalk, Conn., as president and chief executive officer.

John R. Harkness: Appointed vice president-marketing for Librascope Division, General Precision, Inc., Glendale, Calif. Harkness formerly was manager-electronics for Bendix-Pacific Division.

Henry Feldmann: President of FXR, Inc., Woodside, N.Y., elected to the board of directors of Amphenol-Borg Electronics Corp. following the merger of FXR and Amphenol-Borg. FXR becomes an Amphenol-Borg Division with Feldmann continuing as its operating head.

L. Berkley Davis: Vice president of General Electric Co. and general manager of GE's Electronic Components Division, Owensboro, Ky., re-elected president of the Electronic Industries Association.

Leon F. Goode, Jr.: Thirty-three-year-old scientist, named manager of the *Nike-Zeus* missile system with Surface-to-Air Projects Office at White Sands Missile Range, N.M. Formerly Goode was associate development engineer with Oak Ridge National Laboratory.

Edward F. Canfield: Appointed assistant to the vice president of marketing of Philco Corp.'s Government and Industrial Group, Philadelphia.

Henry E. Schauwecker: Appointed vice president and director of engineering of U.S. Science Corp., Los Angeles. Schauwecker formerly was chief electronics engineer for the Technical Products Div., Waste King Corp., and president of Valor Instruments, Inc., Gardena, Calif.

Nicholas J. Guarino: Joins Space Instrumentation Div., Technology Instrument Corp. of Acton Mass., as aeromechanical engineer. Previously served at the AF Cambridge Research Laboratory and as project engineer at Wright Field Propulsion Laboratory.

Dr. Lewellyn T. Boatwright, Jr.: Appointed director of engineering for Sparton Southwest, Inc., Albuquerque, N.M. Prior to joining Sparton, Dr. Boatwright was chief of the radiac instrumentation section in the Research Directorate at the AF Special Weapons Center.

Dr. Walter K. Volkers: Elected president, director and chief executive of Lionel Corp.'s Electronic Laboratories, formerly Anton Electronic Laboratories, Brooklyn, N.Y. Prior to joining Lionel, Dr. Volkers was vice president of research and development for the Massa Division of Cohu Electronics, Inc.

George F. Anisman: Appointed western region manager of Telecomputing Corp., Los Angeles. Formerly, Anisman was director of marketing for the Whittaker Controls Division.

R. J. Bailey: Appointed vice president of English Electric Corp., and continues as manager of the Marconi Instruments Division, Englewood, N.J.

Bernard M. Brenner: Named manager of the Advanced Development Dept. of Ampex Instrumentation Products Co., Redwood City, Calif.

Howard M. Wittner: Named manager of marketing at General Electric's Missile and Space Vehicle Dept., Philadelphia. Wittner, formerly manager of unmanned spacecraft projects, MSVD, replaced **D. T. Atkinson,** recently named executive vice president of Communication Satellites, Inc.

Dr. Lothar W. Nordheim: Chairman of the Theoretical Physics Dept. and a senior research advisor at General Dynamic's General Atomic Division, elected to a three-year term on the board of directors of the American Nuclear Society.

A. L. Hammerschmidt: Appointed chief engineer, RCA's Missile and Surface Radar Division, Moorestown, N.J. Prior to joining RCA, Hammerschmidt was vice president of the Engineering and Facilities Administration of the National Broadcasting Co.

Claude T. Brown and **William B. D. Harris:** Appointed to the engineering staff, Tele-Dynamics Division, American Bosch Arma Corp., Philadelphia, specializing in underwater telemetry development work.

Col. Samuel W. Bishop, USAF (ret.): Elected president of Electronic Communications, Inc., St. Petersburg, Fla., succeeding **F. W. Godsey, Jr.,** who becomes vice chairman of the board of directors. Col. Bishop was associated with engineering procurement and production aspects of AF missiles and aircraft from 1944 until his retirement this year as Deputy Chief of Staff for Materiel of the Air Research and Development Command.

Joseph A. Waldschmitt: Elected president and chief executive officer of Page Communications Engineers, Inc., Washington, D.C., a subsidiary of Northrop Corp. Waldschmitt succeeds **Esterly C. Page,** elected chairman of the Page board.

Dr. Wilbur H. Goss: Presented the Navy Distinguished Public Service Award for his individual contributions and leadership in guided missile research and development. Dr. Goss, leading scientist in the *Talos* missile program and co-inventor of the supersonic ramjet engine, is assistant director for technical evaluation at the Applied Physics Laboratory, Johns Hopkins University, Silver Spring, Md.

Robert F. Tangren: Former associate manager of research at the Solid Rocket Plant, appointed manager of the newly-created Space Propulsion Division, Aerojet-General Corp., Sacramento, Calif.

Col. Bernard W. Marschner: Vice president of the Holloman Section, American Rocket Society, appointed Professor of Aeronautical Engineering at the Air Force Academy. Col. Marschner's past experience at Holloman includes director of Ballistic Missile Test; deputy director, Directorate of Advanced Technology; and deputy for the Guidance Test Facility.

Thomas H. Armstrong and **William R. Lonergan:** Appointed manager of government relations, and manager of product planning and applied programing, respectively, for the Univac Division of Sperry Rand Corp., New York City. **Richard P. Castanias** appointed national sales manager for Univac scientific computing systems.

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STRUCTURAL DYNAMICS: preliminary design calculations of loads, stresses, deflections of structural components (aircraft, missiles, boosters, space vehicles).

THEORETICAL AERODYNAMICS & AEROPHYSICS: original work supporting design and laboratory project experiments re: hypersonic re-entry vehicles; supersonic craft.

AERODYNAMIC PROJECT DIRECTION: studies & appraisals of preliminary aerodynamic designs for diverse flight regimes, including drag analysis, configuration optimization, performance & trajectory analysis.

AERODYNAMIC ANALYSIS & SYNTHESIS: for both powered & ballistic trajectories.

MATERIALS DEVELOPMENT: refractory coatings on refractory metals, & refractory compounds, cermets, intermetallic compounds. Initiation of investigations to meet new requirements.

EXPERIMENTAL CRYOGENICS: establishment & supervision of cryogenics laboratory responsible for varied investigations including developing environmental control systems for spacecraft.

GUIDANCE & CONTROL SYSTEMS: novel components & system development; thin film devices; circuitry; optical & IR systems & tracking devices.

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BIOCHEMICAL DETERMINATIONS on men and plant systems.

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For detailed information about assignments in the above and other areas please write in confidence to: Mr. George R. Hickman, Technical Employment Manager, Dept. 4F-2

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contracts

NASA

$93,000—**Space Electronics Corp.**, Glendale, Calif., for development of a pulse code modulation (PCM) telemetry system for satellites.

NAVY

$1,200,000—**Lear, Inc.**, Grand Rapids, Mich., for ground support equipment and spare parts for the master attitude reference system (MARS).

$127,000—**General Atronics Corp.**, Bala-Cynwyd, Pa., for theoretical and experimental studies in conjunction with the exploratory underwater defense system ARTEMIS.

ARMY

$35,645,500—**Fluor Corp.**, Los Angeles, for *Titan II*, Phase II construction at Davis Monthan AFB, Tucson, Ariz.

$2,025,700—**Raytheon Co.**, Waltham, Mass., for 20 aluminators for the *Hawk* missile system radar.

$1,790,014—**Bendix Corp., Systems Div.**, Ann Arbor, Mich., for a high-altitude downrange airborne measurement program.

$1,471,102—**Grand Machinery Co.**, Detroit, for rocket motor bodies and fins for M150 assembly.

$1,212,881—**Sylvania Electric Products**, Waltham, Mass., add-on for engineering changes to the *Advent* communications satellite antenna system.

AIR FORCE

$1,131,642—**General Precision, Inc.**, Pleasantville, N.Y., for AN/APN-108 Doppler radar subsystem of the AN/ASQ-48 bombing navigation system.

$40,748—**Kin Tei Div., Cohu Electronics, Inc.**, for ground support equipment instrumentation.

North American Aviation's Space and Information Systems Div., Downey, Calif., from Electronic Systems Div. of AFSC, for 13-month study contract to improve optical satellite observation and prediction techniques. No amount disclosed.

Beech Aircraft Corp.'s Boulder Div., from **General Dynamics/Astronautics**, for tooling, manufacturing and testing of "topping control units" for the *Atlas* ICBM. No amount disclosed.

REQUESTS

The NASA Procurement Office, Marshall Space Flight Center, Huntsville, Ala., will issue a request for proposal ENG 140-61 for design, fabrication, installation and checkout of a complete, approximately 200-ton capacity air conditioning system for installation at Cape Canaveral, Fal.

Proposals are due to be received on or before June 20, 1961, at the Procurement and Contracts Office, Marshall Space Flight Center, NASA, Huntsville, Ala.

The following firms have been invited to participate: American Electronics, Inc., Ground Support Div., 2112 N. Chico Ave., El Monte, Calif.; Carrier Corp., 2015 Peachtree Rd., N.W., Atlanta 9, Ga.; Chrysler Corp., Airtemp Div., 1600 Webster St., Dayton 4, Ohio; Douglas Aircraft Co., Inc., 3000 Ocean Park Blvd., Santa Monica, Calif.; Hamilton Standard, Div. of United Aircraft Corp., Windsor Locks, Conn.; Telecomputing Corp., Advanced Structures Div., 801 Royal Oaks Dr., Monrovia, Calif.; C. G. Hokanson & Co., Inc., 2140 Pontius Ave., Los Angeles 25, Calif.; Trane Co., 871 McCallie Ave., Chattanooga, Tenn.; Worthington Corp., Ampere Station, East Orange, N.J.; York Corp., 525 Plaster Ave., N.E., Atlanta 24, Ga.

NASA suggests that small business firms or others interested in subcontracting opportunities on this procurement make direct contact with the above firms.

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Polaris Guidance

(Continued from page 31)

missile due to ship's motion and subtracts these from the platform accelerometer signals, so that they may be used to erect the platform to local vertical very accurately.

(5) Computes target azimuth and aligns the inner gimbal of the platform to this heading with the aid of SINS as a true north reference, and an optical-electrical servo. At the missile, the misalignment between the SINS and the missile stable platform is measured optically and electrically. This misalignment error, combined with the computed target bearing, gives the final bearing alignment to the missile platform azimuth gimbal.

(6) Continually checks out the guidance system and other missile equipment and displays the missile's state of readiness.

• **Flight mode**—During powered flight, missile pitch-attitude is controlled through the first phase by a programed autopilot, during second phase by inertial-guidance and autopilot subsystems.

Among the major factors contributing to the accuracy or inaccuracy of the guidance system are the computations performed by F/C and missile computer, the SINS inputs, alignments, erection, gyro drift, and accelerometer scale-factor variations. Attainment of accuracy in the missile-borne components is in general more difficult because of strict limitations on size and weight—and the severe penalty of lost range when these are exceeded.

Impact data from test firings of the *Polaris* missile are, of course, classified. However, it can be related that the expression "right in the pickle barrel" has been used to describe the results of several tests. The high proportion of successful tests shots is a record already well documented.

• **Second-generation systems**—Currently, MIT engineers and scientists are designing a second-generation guidance subsystem with industrial support by GE's Ordnance Department (platform) and Raytheon Corporation (computer). Significant improvements in size, weight and accuracy are anticipated, with subsequent improvement in missile range.

A second-generation Fire Control is being designed by GE. The new system, designated the MK 84, will provide greater versatility and operational flexibility for the FBM system. It makes extensive use of new digital computing concept in packaging will make the techniques and will be more automatic than its predecessor, the MK 80. A new concept in packaging will make the MK 84 easier to operate and maintain. ⁂

—when and where—

Instrument Society of America, 3rd International Symposium on Gas Chromatography, Michigan State University, East Lansing, June 13-16.

Joint ARS-IAS Meeting, Ambassador Hotel, Los Angeles, June 13-16.

Applied Mechanics Conference, American Society of Mechanical Engineers, Illinois Institute of Technology, Chicago, June 14-16.

American Society for Testing Materials, Annual Meeting, San Francisco, June 16-21.

IAS Symposium on Space Flight and Reentry Trajectories, Paris, June 19-21.

Heat Transfer and Fluid Mechanics Institute, University of Southern California, Los Angeles, June 19-21.

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editorial . . .

Put the People 'in the Picture'

PRESIDENT KENNEDY'S recognition in his special message to Congress that we are indeed in a race with the Russians to put a man on the moon is gratifying.

To his declaration that it is time for this nation to take a clearly leading role in space achievement, we might add that it is well past time. But we would feel somewhat better about the whole program if the President had been less nebulous about the purpose of the exercise. He was frank in pointing out that our drive into space may cost up to $9 billion over the next five years. He was less than clear in explaining why such an expenditure is necessary.

"We go into space because whatever mankind must undertake, free men must fully share," the President told Congress. A noble sentiment; but the message might have been more effective if he had spelled out more specifically in terms of national prestige and military security just why it is necessary to expend the money and effort on such a mammoth undertaking.

There is no need for us to emphasize the reasons here. We have outlined them before. But members of the lay public, taxpayers who are being asked to foot the bill for this program, deserve answers to such questions as why we are not spending this money on projects closer to home—"something like cancer research."

This reflects one of the most irritating and fallacious arguments against space expenditure yet devised, based on the false assumption that if we don't spend money on a lunar expedition, we will perhaps spend it on cancer research. We will not. Cancer has been with us a long time and we have yet to spend that kind of money trying to find a cure for it, although we have been financially capable of doing so.

This should be explained to the taxpayer. So should the positive reasons why we are going into space. Yet the President gave no indication in his message of any reason beyond a desire to "win the battle for men's minds" by putting an American on the moon before a Russian gets there.

The Administration is doing itself and the nation a disservice by refusing to acknowledge the valid military reasons why we must not let the Russians dominate space.

It is apparent from reading between the lines of the message and from a study of the funding outlined that the military mission is not to be neglected. It would be more forthright to acknowledge this as one of the purposes of our stepped-up space program—and to implement it with direct financing.

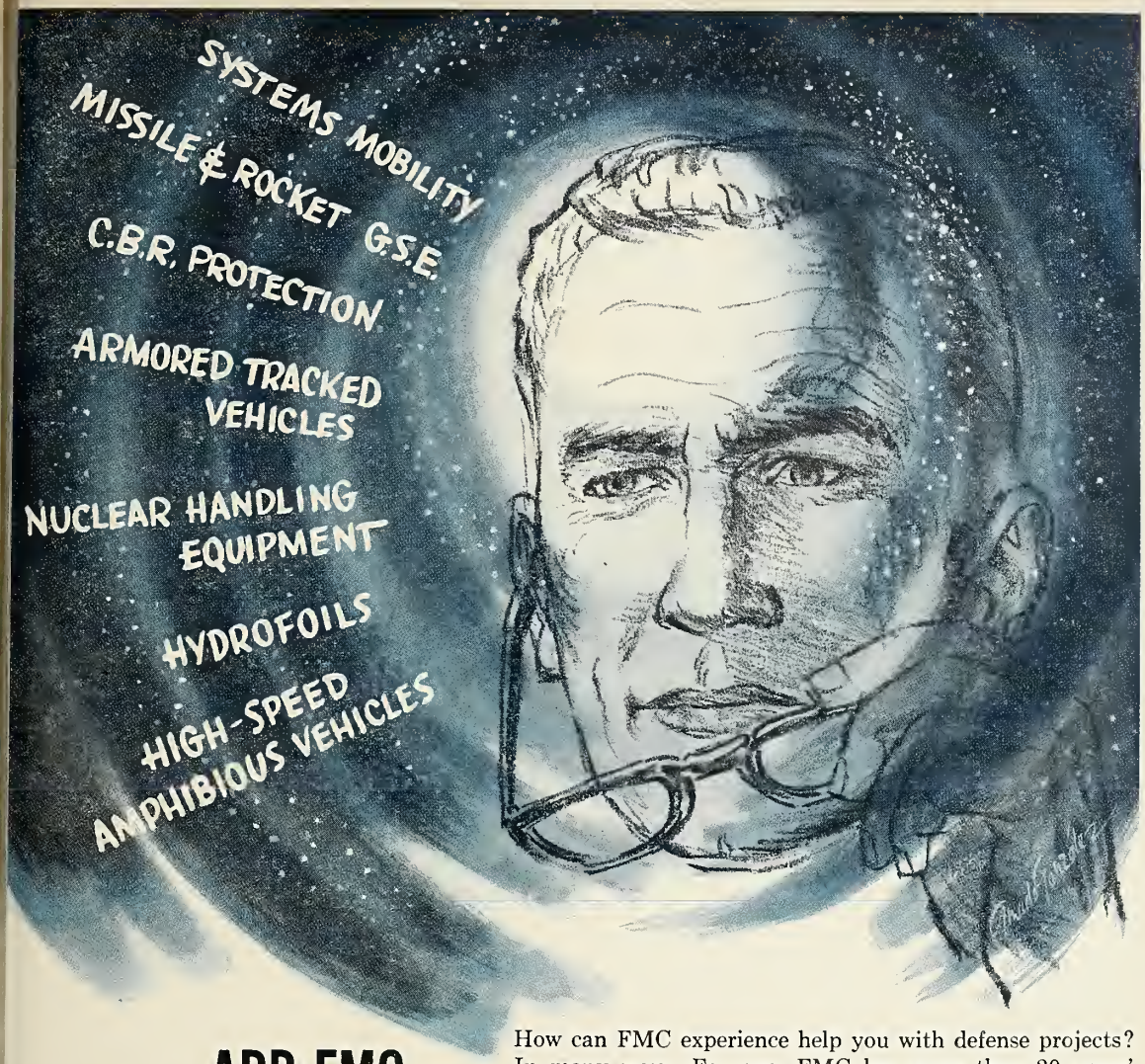
Such a course of action, we feel, would lend a greater sense of urgency to the program.

WE WOULD be less than just, however, if we failed to acknowledge a differing point of view. It is ably expressed by a man who has a much more intimate knowledge of crash programs than we do. Dr. Simon Ramo, executive vice president, Thompson Ramo Wooldridge, Inc., had this to say on the subject to the Fifth Symposium on Ballistic Missile and Space Technology:

"It would be wrong . . . to imagine that the quickest and surest way to create a successful crash program is to be certain that the public as a whole accepts the need. This reasoning starts from the idea that only by wide public appreciation will the funding, the priorities, and the broad backing needed for a large program be achieved. There is truth to this, but it is a remarkably self-complicating phenomenon. If a program is sufficiently well known, then there will inevitably be too many in the act—some anxious to help, others merely anxious to participate, all anxious to have a say—and our national habit is to feel compelled to honor all of this interest. We fall into a pattern of broad participation by everyone in most aspects from basic decisions on the planning of the program to its implementation and its detailed execution. What results may be called a crash program, but it can be so in name only. It may be large and well known, but it will not move along nearly so fast as it might otherwise have been able to."

The pitfalls outlined by Dr. Ramo certainly must be avoided in our lunar effort. But we still feel further public definition of why we are sending men into space is required if the program is not to bog down in a confusion of objectives.

William J. Coughlin



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For commercial use, Varian supplies precision test systems such as the V-7200 Noise Measurement Test Set, to measure amplitude or frequency modulation noise from microwave sources.

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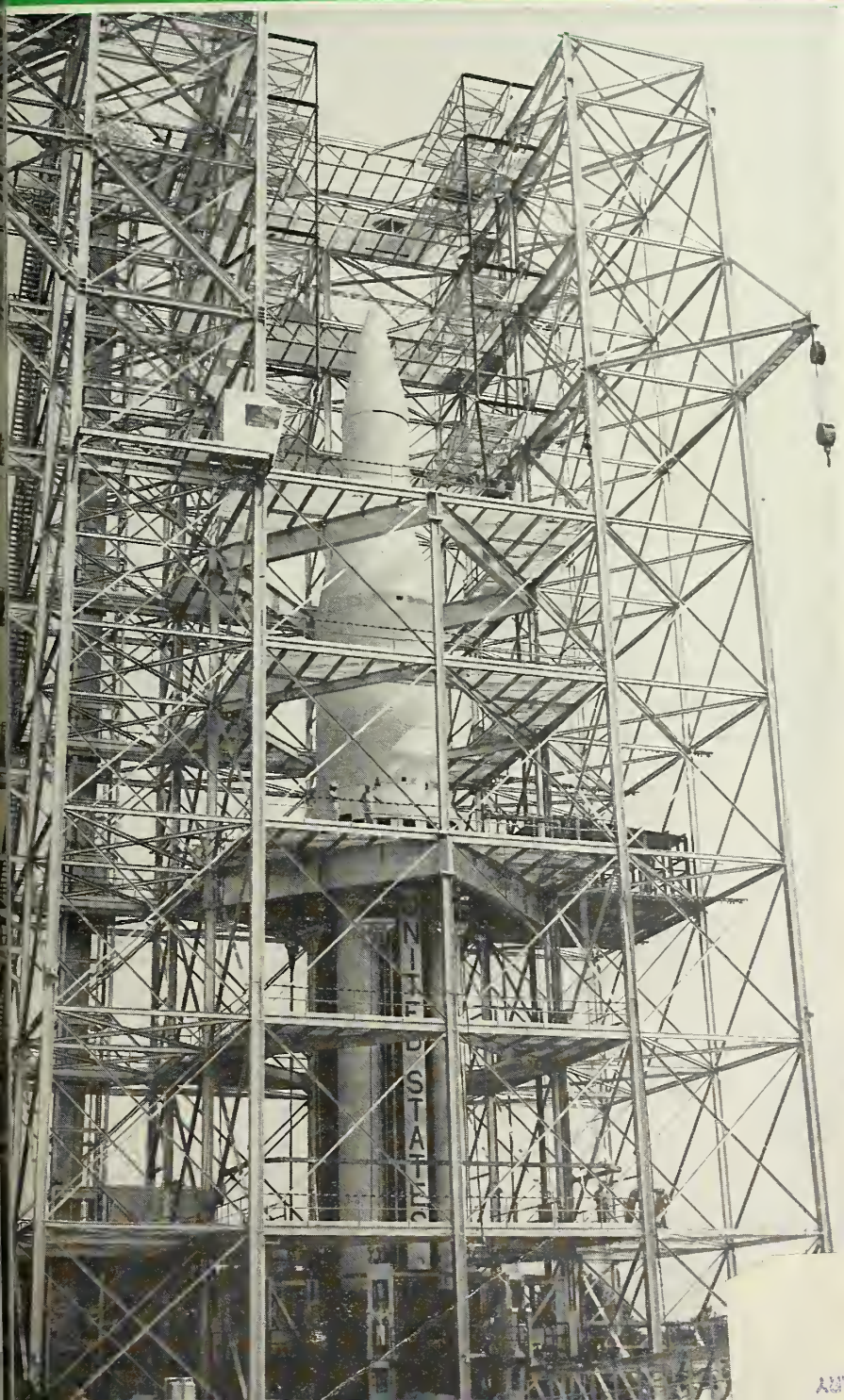
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JUNE 19, 1961

missiles and rockets

THE MISSILE/SPACE WEEKLY

JUN 1961
HOUSTON



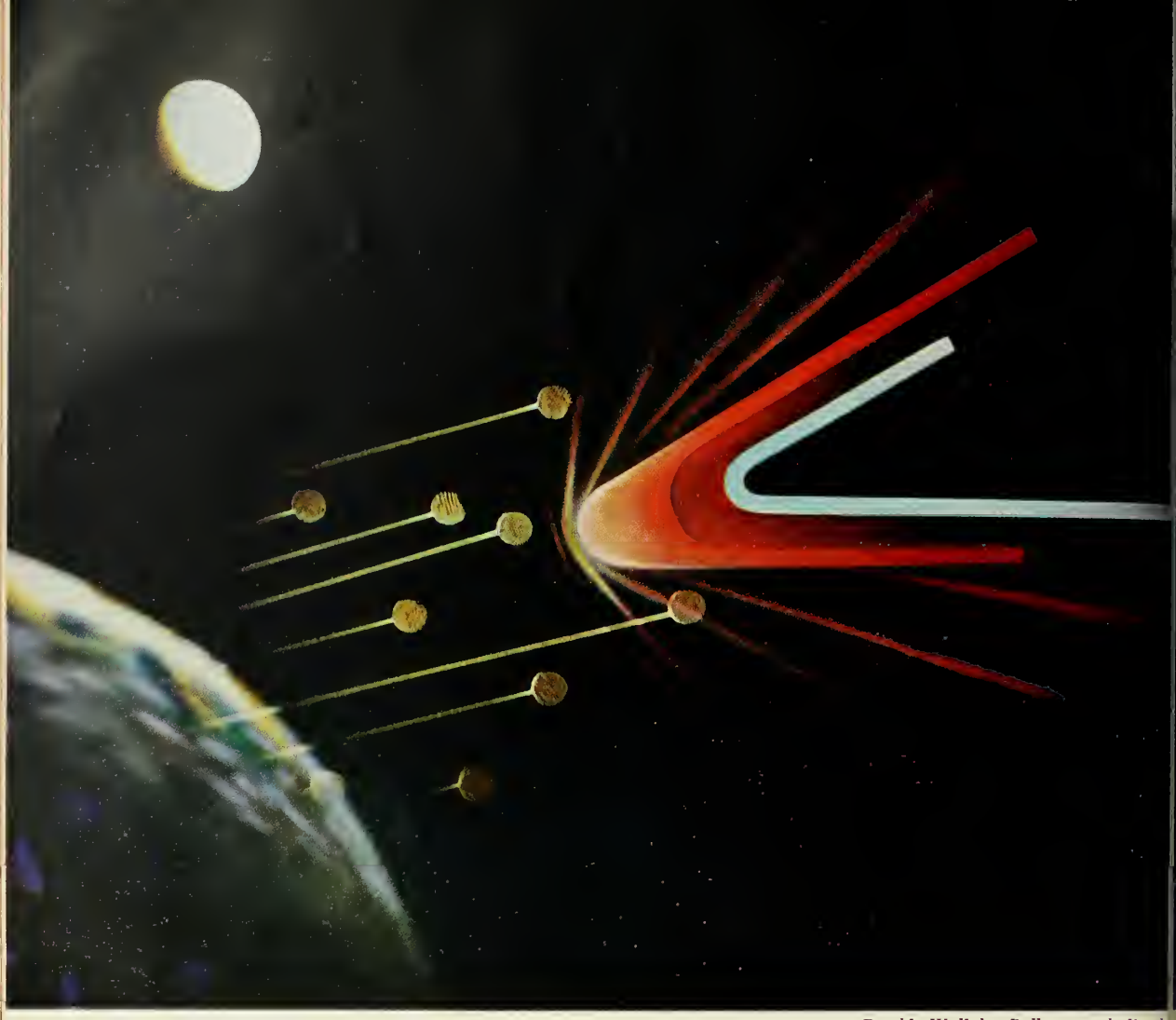
Time is Running Out For Beef-up Of U.S. ICBM's

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- Dividend from Explorer VIII
- AF Gets Its 1st Ion Engine

Saturn C-1 in Test Stand

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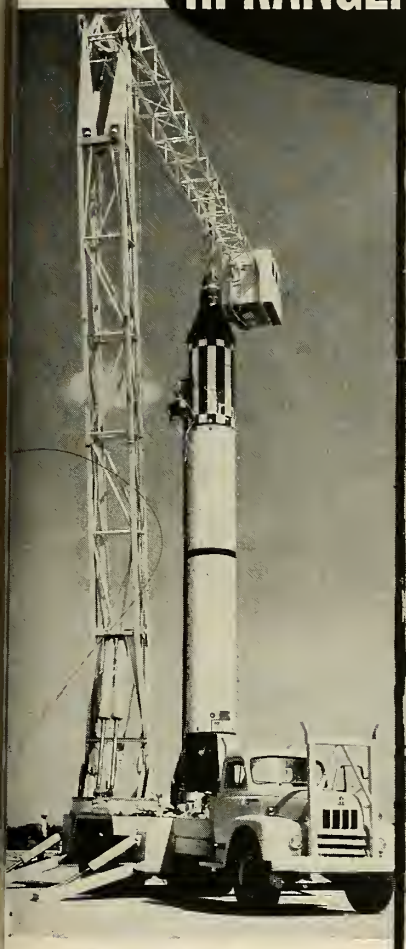
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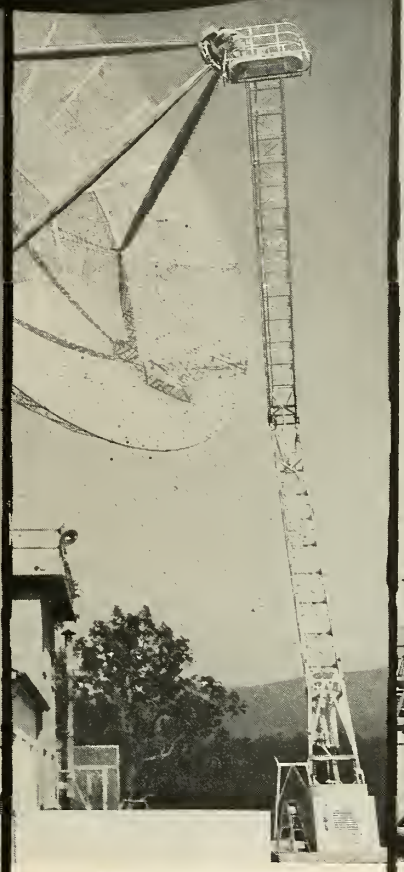
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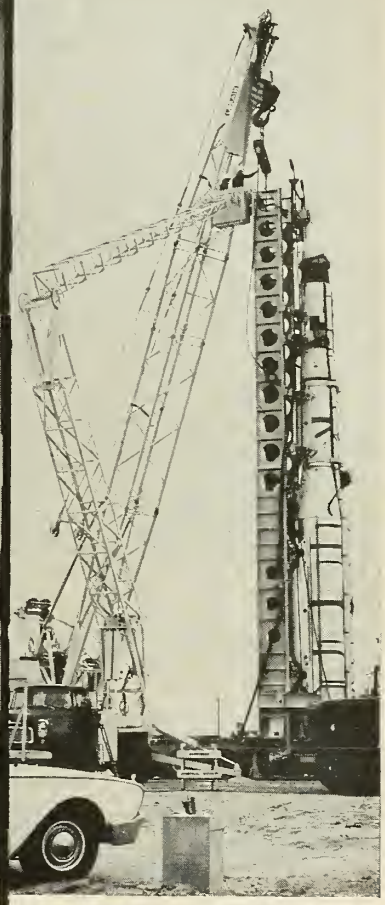
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missiles and rockets

Volume 8, Number 25 June 19, 1961

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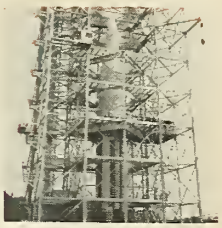
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THE COVER

Assembled flight version of Saturn C-1 booster, with inert upper stages, stands in dynamic test stand at Huntsville. The Saturn program is being accelerated. See p. 15.



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—letters—

Bioastronautics Recognition

To the Editor:

Congratulations on the fine bioastronautics article by Heather M. David in the May 29 M/R. You did a remarkable job of organizing a wealth of diverse material and presenting it factually and succinctly. As a matter of fact, the entire issue deserves praise for bringing attention to what is perhaps the pacing factor in this country's manned space flight efforts.

I particularly want to thank you for your mention of Spacelabs and the work we are carrying out here to further bioastronautics progress. Your recognition of our relatively small group is most gratifying. It is our hope to continue as an important factor in the field of bioastronautics and to grow into a large company by contributing worthwhile ideas and products in our field of specialty. The struggle in pioneering a new field is sometimes difficult and it is a source of considerable encouragement to receive the recognition of a national publication.

James A. Reeves
Executive Vice President
Spacelabs, Inc.
Van Nuys, Calif.

Freedom and Self-Control

To the Editor:

I want this letter to be an answer to the letter written by Mr. Dewey Thompson, Washington, D.C., published in M/R May 22, p. 6 *(cancelling his subscription in protest of the May 8 editorial, which he alleged was "the meanest and most shameful criticism and ridicule" of Astronaut Shepard and "reads like communism."—Ed.).*

Dear Mr. Thompson:

Your letter sounded worse than what you called the magazine, although you used only two sentences. Since you have cancelled your subscription, maybe this magazine will have to forward a copy of this letter to you.

I believe in the freedom of the press and the rest of the freedoms that go with our democratic ways of life, but I also believe in control of this freedom, just like the control you have at your home of how much you want your neighbors to hear or not to hear.

I was in the blockhouse at Cape Canaveral when *Vanguard's* "first" exploded on the pad. I can still visualize the expressions on the faces of every individual at that time in the blockhouse. Had the press played a lesser role in the program, the pill would have been easier to swallow.

The last paragraph of Mr. Coughlin's "The Debacle at Cape Canaveral" (May 8 editorial) summed up what the press should or should not do in all future shots. I agree with him that a great deal can be done to eliminate the revolting display the press had shown toward our national prestige. All we ask of the press is to use a little "control" of common sense toward

e feelings of individuals and, finally, of r nation. This "control" I suggest is al-dy in use by the press—those editors o sit in an air-conditioned office all the e and read every article turned in by reporters before they finally go to press.

Joseph Y. Yuen
Washington, D.C.

lercury Escape Rocket

the Editor:

Your article on the decision in the on race (M/R, May 1, p. 12) pre-ted an interesting evaluation of the oblems facing our country in coming ars.

We noticed that in your discussion of oject *Mercury* you refer to the "escape ckets" mounted on the capsule. GCR uilt the *Mercury* escape rocket under sub-ntract for McDonnell Aircraft Co., and is a single solid-propellant rocket. The -foot rocket sometimes appears to be ore than one motor because of the ique design with three canted nozzles.

Janet E. McKim
Public Relations Representative
Grand Central Rocket Co.
Redlands, Calif.

he Skeptical East

o the Editor:

I have just read with keen interest our article, "Report on Russia's Man-in-Space Achievement" (M/R, April 17, p. 14), because there are prevailing rumors such as "Mystery of Soviet Spaceman—Truth or Hoax?" (U.S. News, May 1, p. 62).

I can't help reading with deep doubts the statement in your report that "the White House disclosed that the U.S. world-wide radar net had tracked the *Vostok* throughout its flight."

Space exploration is, needless to say, becoming an important frontier of the cold war between East and West. Any achievement in the field is a powerful weapon for persuading the uncommitted people the world over to demonstrate the superiority of its social system because the scientific feat is a fact no one can deny.

On the occasion, some further reports, remarks or opinions by your distinguished editors on this serious problem will be helpful for us, the people of the free nations.

Dr. Hikosaburo Ataka
Dean of Academics
The Japan Defense Academy
Hayama, Kanagawa,
Japan

Sparrows by Sperry

To the Editor:

While I am not given to quibbling over small details, an error on p. 27 of M/R, June 5 cannot be left uncorrected. The caption referring to the missiles mounted on the F7U fighter identifies them as an "earlier version of the Raytheon *Sparrow*" when, in fact, the missiles pictured are Sperry *Sparrow I's.* As you are probably aware, the *Sparrow I,* for which Sperry was the prime system contractor, was this nation's first operational air-to-air missile; those of us who had a small part to play in its development are still justifiably proud of the design, development and test record which was established during this program.

As a point of information, the picture of the F7U was taken in early 1955 during the evaluation demonstration program at Pt. Mugu, when a concentrated program of operational test firings was performed by Development Squadron 4 (VX-4) in cooperation with Sperry's Field Test Unit, which was based at Pt. Mugu from 1949 through 1957.

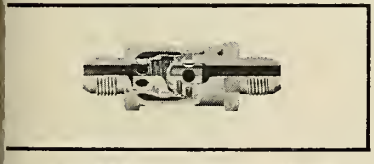
We certainly do not wish to take any present credit away from Raytheon and their *Sparrow III,* but feel that you will want to keep the record straight on who developed the "earlier version" pictured in your publication.

Douglas A. Heydon
Air Armament Div.
Sperry Gyroscope Co.
Great Neck, N.Y.

M/R disagrees that it is an "error" to refer to Sperry's Sparrow I as an earlier version of Raytheon's Sparrow. We did not, of course, intend to deny Sperry credit for the original weapon, of which it can well be proud.—Ed.

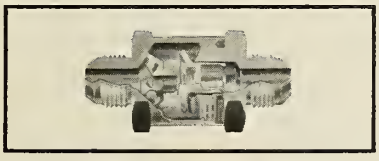
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The Countdown

WASHINGTON

rst Italian Jupiters Operational

The first Italian-manned *Jupiter* IRBM's are reported to be on operational alert in Italy. The 1500-mile Chrysler missiles are under the command of the Italian Air Force's 36th Aerobrigade Jupiter Missile Group. Italy plans to deploy a total of two 15-missile *Jupiter* squadrons.

avy Crockett Slips Some

Delays in deployment of the Army's nuclear-tipped *Davy Crockett* have been disclosed. The Army had planned to buy operational *Crocketts* for the first time in FY '62. Now this plan has been cancelled. The cause appears to involve tactics.

edeye Slips More

The Army is now planning to "standardize" the Convair *Redeye* surface-to-air missile this year and open the way for procurement possibly in late FY '62. Originally the Army planned to buy its first *Redeyes* in FY '61. The plan apparently was cancelled for financial reasons. Technical hold-ups also occurred, but the Army says these did not cause the production delay.

"Premium Effort" for Titan II

The Air Force is pumping an extra $270,000 into the *Titan II* R&D program to launch the first *Titan II* test missiles at the earliest dates now scheduled. Originally the first two were to be launched before July 1. Now the first launching is expected this fall—when the costs of *Titan II* are expected to be running at about $1.5 million a day.

More CBR Rockets Coming

The Army's chemical warfare procurement appropriation request for FY '62 is nearly $55 million. of this more than $24 million will go for CBR rockets. Another $1.5 million is earmarked for multiple rocket launchers.

Polaris Sub Costs Rising

The pricetag on the new *Polaris*-launching Lafayette Class submarines is $116.2 million. That is a jump of $11 to $19 million over the first two classes of nuclear-powered subs in the *Polaris* program. About two-thirds of the cost of the subs is for shipbuilding, one-third for *Polaris* system equipment.

INDUSTRY

Managerial Help for Titan

The Air Force is solving its installation and check-out problems at *Titan* ICBM bases by bringing in extra managerial talent. In the *Titan* program Martin has given I&C subcontracts to Norair, RCA Service, Federal Electric and Hughes. The Air Force says the move was made after troubles in *Atlas* I&C and word from Martin that it "lacked adequate management in depth" to handle the entire job. The Air Force anticipates a saving in costs. Martin's fixed fee will remain unchanged.

R&D Intelligence

PCM telemetry system will be adopted for *Minuteman*. It will work in serial with diversity recording on seven tracks at 5800 bits per inch. . . . *Titan II*, which is much larger, will employ seven tracks and serial PCM, but with only half the bit rate. . . . Varian Associates has a $3.9-million Army Signal Supply contract to develop an operable super-power microwave amplifier to defend against "extra-atmospheric offensive vehicles"—types unspecified. . . . Navy has dropped development of a two-stage *Sidewinder* in favor of a faster, longer-range, single-stage version which will have both radar and infrared guidance.

There with the Booster

Although the FCC hasn't decided yet who will build a commercial communications satellite system (see p. 14), United Technology Corp. is already offering to build the booster for the General Electric group. UTC says it will use is own money to compete with the $8-million price-tag on an *Atlas-Centaur*.

Navy Buying Swallows

High-performance *Swallow* (SD-4) reconnaissance drone killed by the Army may be bought by the Navy for use as targets. The Army version will be stripped down, leaving just the combination inertial guidance (with command override) system. Rockets will be added to wing tips to up speed over Mach 1.

Titan Silo Blowup Hydraulic Failure

Air Force officials have finally disclosed that the explosion last December of a *Titan I* in an OSTF at Vandenberg AFB was caused by a failure in the launcher elevator hydraulic system. The elevator dropped so suddenly it caused a structural failure in the missile, releasing LOX and RP-1 which then ignited.

INTERNATIONAL

Seacat Interest Spreads

Spain, Portugal and several South American countries are looking over the Short Brothers & Harland *Seacat* ship-to-air missile The bird already is being bought by Britain, Germany, Sweden, Australia and New Zealand.

Overseas Pipeline

The French are getting ready to test the *Masurca II* ship-to-air missile at their Mediterranean Missile Test Center. Still under development, the missile is said to have better performance and to be cheaper than the U.S. *Terrier*. . . . The British are expected to start replacing *Corporal* units with the British Aircraft *Blue Water* and skip plans to phase in *Sergeants*. . . . Contraves A. G. of Switzerland is building a new antiaircraft missile with improved propellant to replace its *RSD 58* . . . and London pubs are now offering two new cocktails: Space Rocket and Into Orbit.

The Missile/Space Week

Shots of the Week

After a two-month period with no shots, the latest *Discoverer (XXIV)* took a disappointing plunge into the Pacific June 8 shortly after first-stage separation.

Experts are checking the four minutes of data received from the payload to determine cause of the malfunction.

Nature of the payload was not disclosed. The Air Force said that the reason for the holdup in shots was for modifications in the satellite and launching pad, although it declined to spell these out.

On the brighter side, the Navy successfully fired its advanced *Polaris* missile from a launch pad at Cape Canaveral June 12. And the U.S. Army's *Pershing* scored an accurate hit in a limited-range firing from Cape Canaveral June 9.

Saturn Finds a Friend

The Navy has moved in to rescue NASA's *Saturn* booster, virtually marooned at Huntsville because of a broken lock on the Tennessee River.

The giant booster will travel only 50 miles on its specially designed barge, the Palaemon, to the Wheeler Dam, site of the broken lock. It will be moved by rail to a point past the lock—a distance of about a mile. Then it will be loaded on Navy barge below the dam and make the remainder of the trip (more than 1000 miles) to Cape Canaveral.

The barge, a former floating warehouse, is 261 ft. long x 48 ft. wide.

Astrodome for Astronaut

The orbital *Mercury* capsule will have a view window above the astronaut's head to increase his observation field.

A NASA spokesman told the recent joint International Astronomical Society—American Rocket Society meeting that the only other change in the capsule involved an improved fairing over the mating clamps holding the capsule to the missile. He said this change was made to correct buffeting that occurred during Shepard's flight.

NASA also said the *Mercury* project was actively planning a manned 18-orbit, 24-28-hour mission. This mission would jump directly from 3 orbits since it would take 18 orbits to bring the capsule back to the same recovery area for a 3-orbit mission. No date has been indicated, but three-orbit missions would be made first.

At the same meeting, AF Space Study Committee Chairman Trevor Gardner estimated the cost of a manned lunar mission at about $10 billion.



Air Force Bullpup Trainer

TACTICAL AIR COMMAND test pilots prepare for pre-production flight testin of the GAM-83 trainer built by the Martin Co. First production trainers will be turne over to F-100 and F-105 jet pilots in July. Training missile nears Mach 2, has 30,00 ft. range and flies at altitudes up to 40,000 ft. The Air Force also disclosed that it ha started qualification tests at Eglin AFB on the GAM83A and F-105 with firing of Bullpup from the supersonic tactical fighter-bomber. Test was successful.

RAC in for ORO

Research Analysis Corp. is the name of the Army's replacement for Operations Research Office.

The non-profit defense research organization will have as chairman Dr. Hector Skifter, president of Airborne Instruments. Other trustees are Gen. Omar Bradley (ret.), John Connor, Hendrick Bode and Gen. James McCormack (ret.).

The corporation was set up at a meeting June 7 in Washington, D.C., between Army officials and research group representatives. The Army and ORO, part of Johns Hopkins University, parted company after long-standing disputes over control of research (M R, June 5, p. 11).

LeMay Okayed by Senate

The appointment of Gen. Curti E. LeMay as Air Force Chief of Sta was made official by the Senate.

The Senate also approved the re tirement of Gen. Thomas D. Whit with the rank of General.

Transit Training to Start

The Navy is planning a prototyp navigating exercise this summer fo its *Transit* satellite, scheduled to g operational in fall of 1962.

The *Transit* system consists c four satellites on prescribed orbits, network of five ground stations, computing center, a data injectio center, and shipboard and aircra navigation equipment. Satellites wi be launched with *Scout* vehicles.

NBS Digs in in Suburbs

National Bureau of Standard broke ground last week on a $104 million research facility at Gaither burg, Md., near Washington, D.C.

At ground-breaking ceremonie Commerce Secretary Luther Hodge stressed the "pressing demands" c science and technology for increasin competence in the science of measure ment.

First building to go up will be a engineering mechanics laboratory

his will house a new megapound ead-weight testing machine which ill provide urgently needed force easurement standards to meet the ultimillion thrust requirements of e space program.

The lab also will contain a grav- chamber, 100,000- and 300,000- und dead-weight machines, vertical nsion and compression testing ma- ine capable of loads up to 10 mega- unds, and a horizontal testing achine with a capacity of 2.3 mega- und loads in compression and 1.5 egapound loads in tension.

Plans call for a continuing con- ruction program leading to total re- cation of the NBS Washington facil- ies at Gaithersburg between 1963 nd 1965. Follow-on construction will rovide a radiation physics laboratory ith a linear accelerator, seven gen- ral-purpose laboratory buildings, a umber of special-purpose labora- ories, and an atomic reactor.

uccessor for Khrunichev

New top man in the Soviet rocket nd space program is Konstantin N. udnev.

Rudnev, former chairman of the tate Committee for Defense Tech- ology, was picked by the Soviets to eplace Mikail V. Khrunichev, who ied of a heart attack two weeks fter his appointment to the new post.

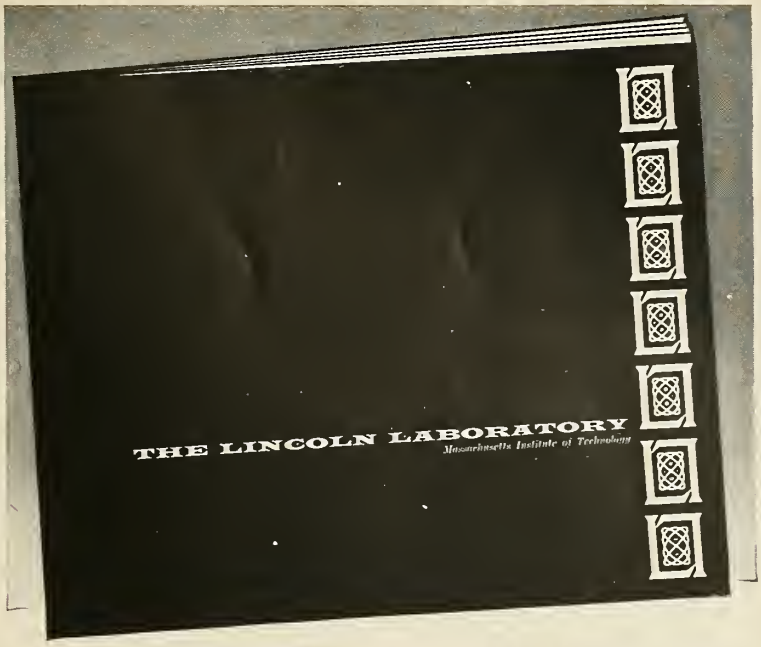
Rudnev's promotion to Chairman f the State Committee for the Co- rdination of Scientific Research Work carries with it a Deputy Pre- niership. Western observers see the ost as one of the most powerful in he USSR.

Mystery at Jodrell

Mysterious beeps from outer pace continued to baffle scientists nanning Britain's giant radio-tele- cope at Jodrell Bank.

The signals have been heard on a requency close to the 922 mega- ycles on which the "lost" Soviet ocket is supposed to transmit. How- ever, the Bank has not been able to enter the source of the mystery signal in the telescope's main beam.

Soviet scientists have asked co- peration from the Bank in an at- tempt to reactivate the Venus probe communications system. Contact with the probe, launched Feb. 12, was lost Feb. 17. It is now estimated to be 62 million miles away.



The Lincoln Laboratory, Massachusetts Institute of Technology, announces a major expansion in its program. We urgently request the participation of senior members of the scientific community in our programs in:

RADIO PHYSICS and ASTRONOMY
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- **Space Surveillance**
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- **A more complete description of the Laboratory's work will be sent to you upon request.**

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ALL QUALIFIED APPLICANTS WILL RECEIVE CONSIDERATION FOR EMPLOYMENT WITHOUT REGARD TO RACE, CREED, COLOR OR NATIONAL ORIGIN.

Two crucial decisions . . .

Will Time Run Out for Kenned

No major increase yet in numbers of missiles due by '65; Polaris & Minuteman key factors

by James Baar

PRESIDENT KENNEDY must decide within the next few months whether to increase the nation's strategic missile force or watch his ability to do so erode away.

Even a decision within the next several months will apparently shave matters so closely that it will recall some of the defense budget barbering under the old Eisenhower Administration.

Despite the Administration's generalized claims that it is building up the nation's ICBM forces, newly-available figures clearly show that no large build-up has yet taken place.

So far the Kennedy Administration has accelerated the deployment of *Polaris* submarines and fixed-site *Minutemen*. It also has bought up short-run options to do much more in certain key areas.

But that is all. There has been no great change in the total number of strategic missiles planned by 1965. Moreover, in the opinion of some experts, a decrease in real deterrent power may be the price that is being paid for the acceleration of *Minuteman* deployment.

The first of two key decisions confronting Kennedy involves *Polaris*.

The Administration is requesting that the total number of authorized *Polaris* submarines through FY '62 be brought to 29. This increases by 10 the total sought by the Eisenhower Administration through the new fiscal year.

The Administration also accelerated the laying of keels for *Polaris* submarines and accelerated the development of the 2500-mile-range *Super Polaris*.

As a result, the 29th *Polaris* submarine will be deployed in January, 1965, instead of 1967 and the *Super Polaris* or A-3 will be operational about mid-1964 instead of 1965 or possibly later.

However, the Kennedy FY '62 defense budget omits any funding for long-lead-time items for any *Polaris* submarines beyond the 29th. These long-lead items—mostly nuclear reactor parts—take about 30 months to fabricate. Unless fabrication of more long-lead items for more *Polaris* submarines is started this fall, there will be a commensurate gap between the completion of the 29th submarine and any future ones.

In newly-released secret testimony before the House Defense Appropriations Subcommittee, Vice Adm. William F. Raborn, head of the *Polaris* program, testified:

"To maintain the rate of one submarine per month delivery schedule which the present fiscal year 1962 funds would continue, would require long-lead-funds in the amount of about $175 million. This would provide for all long-lead-time items for 10 additional submarines. . . ."

But Raborn added that if the $175 million is not made available—and so far the Administration has not requested it—"there would be a month by month gap until the funds were made available."

The Navy has consistently presse for the building of a *Polaris* fleet of 4 submarines. However, in recent month there have been a number of hints fro the Administration that a smaller nur ber is being considered—possibly r more than the 29 already requested.

Earlier this year Navy Secreta John B. Connally testified at a Hou hearing when asked how many *Polar* submarines the Administration planne eventually to build:

"I cannot tell you. I am certain w need 29. I am certain we probably nee more than that. How many more, I c not know. I think at the time we con up in 1963 we will have a better ide how many we need."

Asked if any time would be lo by this delay, Connally said: "No, I d not think we will. I think we have tim With the acceleration of the prese program . . . I think we have some tim now in which we can review this who matter, review the threat, take the con bined information of all the servic and determine what capabilities fro a strategic standpoint we must have."

He did not discuss the coming ga that will develo unless more lon lead items are pr cured.

The secon strategic missile d cision facing Ke nedy involves *Mi uteman.*

The Admini tration is currentl planning to de ploy 12 50-missi squadrons of fixe site *Minutemen* an accelerated rat The Administra tion also is dou bling on a standb basis its capabilit to manufactur *Minutemen.*

However, a the same time the Administratio has indefinitel stretched out th mobile *Minutema* R&D program, car celled all firm plan to deploy mohil *Minutemen;* an

A Quick Look at the Polaris Program

(in millions)

Total FY '56 through FY '61		**$4,852**
Total requested (NOA) FY '62		
Shipbuilding & conversion	$1,108	
Procurement of Missiles	316.4	
Other procurement	160	
RDT&E	443.2	
Operation & Maintenance	46.6	
Construction	19.6	
	2,093	
Total through FY '62		**$6,945**
FY '63 (estimate for completing 29-sub program only)	$680.4	
FY '64 (29-sub estimate)	376	
Total through FY '64 (29-subs)		**$8,001**
Polaris RDT&E Costs by Model		
Poloris (A-1) (completed with FY '62 funding)	$730	
Poloris II (A-2) (completed with FY '62 funding)	576.3	
Super Poloris (A-3) (totol expected including $70.7 in FY '61 ond $254 in FY '62)	665	
Totol	$1,971.3	

uild-up of U.S. ICBM's?

ut back from 14 to 12 the total num-
er of nine-missile *Titan* squadrons
anned.

In defending these cutbacks, the
dministration neglected to bring out
number of points.

The justification given for the
obile *Minuteman* stretchout was that
ie contractors would be unable to
ndle the acceleration of deployment
f the fixed-site *Minutemen* and con-
nue with the mobile *Minuteman* pro-
ram at the previously planned rate.
sked about this, Maj. Gen. Thomas P.
errity, director of the Air Force Bal-
stic Systems Division, told the House
efense Appropriations Subcommittee
t a closed hearing May 16:

"We knew that it meant a tremen-
ous effort . . . to do both jobs at the
me time. I did not, however, con-
ider it impossible."

"In other words," Gerrity was
sked, "if we really wanted to do it,
could have been done?"

"I believe so," Gerrity said.

The latest Kennedy defense budget
or FY '62 contains no money for the
obile *Minuteman*. The $85.7 million
ppropriated in FY '61 for the mobile
Minuteman will be spread over the
ew fiscal year. As a result, the Air
orce contends the program will slip a
inimum of 18 to 24 months.

The justification given for cancelling
he last two *Titan* squadrons was that
hey could not be deployed before the
Minuteman deployment will be in full
wing—and 100 *Minutemen* could be
eployed for the cost of the 18 *Titan*
I's in the two squadrons.

However, the Administration so far
as not ordered up even 18 extra
Minutemen—let alone 100 to replace
he cancelled *Titans*. The *Minuteman*
arries a much smaller warhead than
Titan II and, therefore, is far less suit-
able for certain missions. And the re-
liability of the final two *Titan II* squad-
rons will be the highest of the *Titan*
force.

Finally, the FY '62 *Minuteman* ac-
celeration will result in more rapid
deployment of the fixed-site missiles
but it will not increase the total size of
the *Minuteman* force originally planned
by the Eisenhower Administration.
Both before and after the changes the
total remains about 600.

The Air Force is continuing to push

(Continued on page 47)

New ICBM Five-year Goals . . .

ATLAS

	June, 1960	June, 1961
Total Squadrons	13	13
Soft and semi-hard sites	7	7
Hard sites	6	6
Bases announced	11	11
(Warren AFB has three squadrons)		
Launchers per squadron		
(first)	6	6
(next 6)	9	9
(last 6)	12	12
Total Missiles on Launchers	132	132
Operational to Date (approx.)	8	27*

POLARIS

Total Submarines	21	29*
Ships built, under construction or to be funded	12	29*
Long-lead items only	9	0*
Missiles per submarine	16	16
Total Missiles on Launchers	336	464*
Operational to Date	0	48*
(Three submarines)		

TITAN

Total Squadrons	14	12*
Hard sites (elevator launch)	6	6
(in-silo launch)	8	6*
Bases announced	7	8*
(Three have two squadrons)		
Launchers per squadron	9	9
Total Missiles on Launchers	126	108*
Operational to Date	0	0
(Expected initial operational date: second half 1961)		

MINUTEMAN

Total Squadrons	about 14	12*
Hard sites	9	12*
Aboard trains	about 5	0*
(Mobile program stretched out indefinitely)		
Launchers per squadron		
(fixed silo)	50	50
(trains)	30	—
Trains per squadron	10	—
Total Missiles on Launchers	600	600
Operational to Date	0	0
(Expected initial operational date: mid-1962)		

Total ICBM's on Launchers Planned	1194	1304*

* Denotes change

With Russia in mind . . .

FCC Near Choice on Phone Satellites

AT&T group vies with GE and other missile/space firms: Justice Department warns of trust potential

by William E. Howard

THE FEDERAL Communications Commission is pushing toward a decision this week on a multibillion-dollar question: Who will operate—and get the revenue—from a commercial communications satellite system?

Pitted against each other in the tussle for the big prize are multibillion-dollar corporations. American Telephone & Telegraph and a group of international telephone companies are on one side; General Electric and several missile/space industry firms are on the other.

The issue: Should the FCC allow AT&T and the other carriers to form a joint venture—or should GE and its associates be permitted to form a brand new enterprise which would become a "carrier's carrier," in business solely to sell international message-sending facilities.

Overshadowing the issue is the Soviet spectre. Will they string up a global space network while U.S. companies are still quibbling over who should do what?

This is the FCC reason for haste. Says Commissioner T. A. M. Craven: "We're in a race with Russia. We can't stall on this question."

On the contrary, contends GE, this is the time to pause and study all the questions involved in the venture. It might save time later on.

• **Complexities**—The issue is a complicated one. GE is raising several questions about the proper technical approach and the matter of ownership. The Justice Department has interjected anti-trust considerations which may create further problems. And NASA has stepped into the picture with an alternate plan of government ownership and launching of a satellite system until private industry can take it over.

Some members of Congress feel all these elements have become so involved that the FCC would be wise to take a second look. Says Rep. Olin E. Teague (D-Tex.):

"I think the FCC is wrong in apparently going off on its own without coordination with other parts of the government."

The immediate question revolves around an FCC ruling which would hand ownership and development of a satellite communications system mostly to the international telephone companies. GE is objecting to this ruling on grounds that the ownership plan is too vague and that it would open up an opportunity to "strangle" the missile/space industry. The company has offered an alternate plan which would be carried out through a newly created corporation called Communication Satellites Inc.

The FCC has given interested parties until June 19 to file cross briefs on the ruling and it plans to render a decision in a matter of days afterward. There is considerable feeling that if the decision goes against GE, the missile/space industry will be almost completely shut out of the chance to cash in on this first commercial use of space. But the FCC maintains that no matter what it does about the ruling now, there will be room for action later on.

• **Cross purposes**—Although details of its plan have not been spelled out publicly, AT&T is reported to be considering a polar-orbitting system of satellites which would essentially supplement existing microwave cable facilities. It also would have an experimental satellite ready for launching next year. How soon a system would become operational has not been disclosed.

Through Communication Satellites Inc., GE is challenging almost every aspect of the reported AT&T plan. It contends that "creation of the operational satellite system will not take place as rapidly as it can and should if it is paced by the carriers for orderly 'integration'." Instead, the creation of an operational system should be undertaken immediately "in a climate of competition with other, still useful facilities."

There is sufficient know-how technically in the *Courier* program, GE insists, to begin on an operational system now—and feasibility of space communications will be demonstrated further in *Advent* and *Relay* "before anyone in private industry can launch an experimental satellite."

The GE plan would involve 10 satellites in equatorial orbits (M/R, May 15 p. 24) by 1965—much like the *Advent* system, which it is helping to build for the Army. Questioned by M/R on the relative merits of a polar orbitting or equatorial system, FCC's Craven said he had "grave doubts about *Advent*" as a practical approach for commercial communications.

But GE says that an equatorial approach is required to realize the full potential of international message traffic, since it would cover most of the globe's populated regions. GE raises another point: an equatorial system would require only 20 operating ground stations while a polar system would require many more to provide multi-directional service. Hence, a requirement for numerous ground stations might stifle expansion of the system in countries which could not afford to build them.

• **Hefty melon**—Studies by GE show a potential revenue of some $700 million a year in 1970, rising to $2.5 billion a year by 1980 if global communications are fully exploited and rates are reduced with increased usage. Cost of building the system would be about $218 million.

These are the figures at the heart of the argument over missile/space industry participation in the ownership of the communications system. Presumably under the AT&T plan missile/space firms would be relegated to the role of suppliers and would be allowed only very limited ownership. As one GE official put it: "Will we have to buy stock in AT&T, or what?"

Claiming that AT&T wants ownership apportioned on the basis of use by international communication carriers only, GE is proposing that 50% of the ownership of Communication Satellites Inc. "be open" to all 10 companies who have expressed interest in satellite venture. They include in addition to GE Lockheed Aircraft Corp., AT&T, IT&T General Telephone, Western Union RCA, Press Wireless, American Securities Corp. and Hawaiian Telephone Co.

The remaining 50% of ComSat would be open to ownership by small business and the general public. Such a split-up, says GE, "would avoid domination by any interests"—pointing out that if ownership is apportioned on a use

(Continued on page 47)

Saturn Given 6-9 Month Speed-up

NASA picks four firms as finalists in S-II competition—
Nova to gain most from added booster funds—new concepts disclosed

NASA IS MOVING to speed up he National Booster Program with the election—six to nine months ahead of schedule—of four companies to submit detailed proposals on building the 00,000-lb.-thrust *Saturn S-II* engine.

Finalists in the race to prime contract the largest rocket unit yet to be undertaken by U.S. industry are Aerojet-General, Douglas Aircraft, General Dynamics/Astronautics and North American Aviation. Winner will be named in about three months.

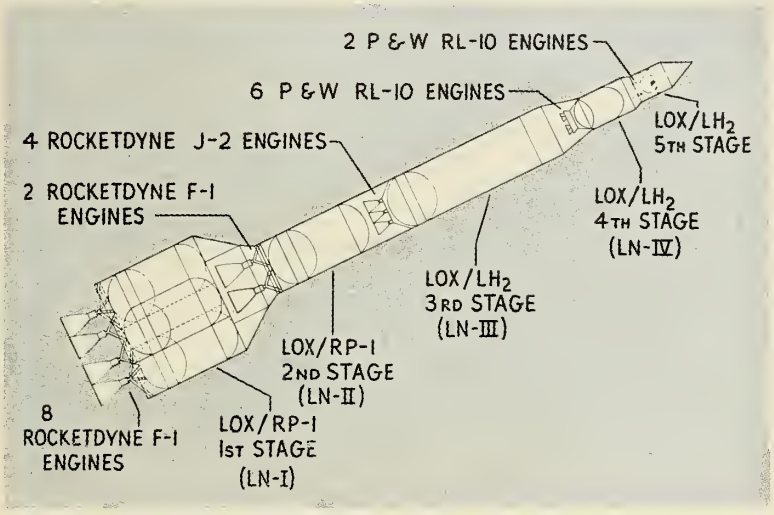
The *S-II* will be used for the second stage of *Saturn C-2* and *C-3*—giving these advanced boosters a payload capacity several times that of *C-1*. It is part of the accelerated booster program intended to send U.S. spacecraft to the moon. President Kennedy has asked for an additional $679 million for the space program.

Testimony by NASA before Congress last week spelled out how the increased funds will be spent. Testimony also revealed proposed new configurations for the *Saturn C-3* and the *Nova* space vehicles (see drawings).

Nova is the prime beneficiary of the added money, although *Saturn* engine development will also gain under the accelerated program. The proposed increase includes $48.5 million for *Nova* research and development. The F-1 1.5-megapound-thrust liquid engine calls for an additional $24.3 million. The *Saturn C-3* will use two F-1 engines and the *Nova*—essentially a *C-3* plus added stage on top of the 8-engine booster—will use a total of ten F-1's.

An additional $12 million is being requested for R&D for supporting "launch vehicle technology" for *Nova*.

A total of approximately $60 million will be required for test and launch facilities for the space boosters. Of this total, NASA has earmarked $24 million for facilities for the F-1 engine program and $7.25 million for the 200,000-lb.-thrust J-2 engine for the *S-II* stage. Ground test facilities for *Nova* stages will require $24 million, and the *Nova* launch complex $4 million.



ONE VERSION of all-liquid Nova. Modified S-II is being considered for 2nd stage.

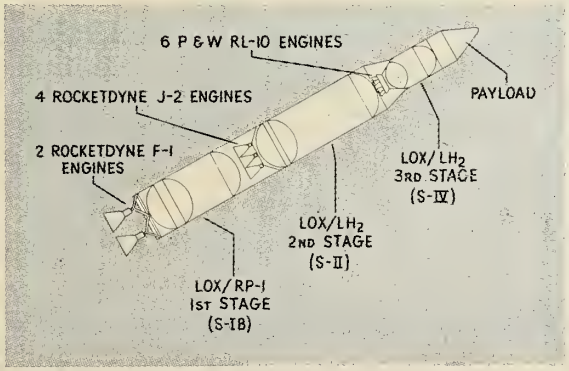
Maj. Gen. Don Ostrander, NASA launch vehicle programs director, said in his congressional testimony that the revised budget permits development of the *S-II* stage for both *Saturn* and *Nova*. He said that the development of this engine, to be started in the next quarter, would advance the program some six to nine months ahead of the schedule set by initial funding plans. The prime contract will probably be signed by October 1.

Ostrander also said that the *Saturn S-I* first-stage booster—a cluster of eight H-1 engines—will soon be assigned to individual contractors for production. First models of this booster were developed and are being produced at NASA's Marshall Space Flight Center.

The *S-IV* stage—used in all three configurations of the *Saturn*—will be redesigned to use six, instead of four, RL-10 engines.

Ostrander pointed out in his testimony that the *Saturn C-2* was sufficient for all unmanned missions—and for *Apollo* up to circumlunar flights if the spacecraft weights can be held to the lower end of the range of present estimates. This, however, is doubtful, and the *C-2* appears to be a "marginal" vehicle for the circumlunar mission.

The *C-3*, with the new *S-IB* first stage—two F-1 1.5-megapound engines—will satisfy requirements for all lunar missions short of actual manned landing on the moon. ❖



SATURN C-3 with S-IB booster will have twice C-2's payload

Sheer serendipity . . .

Explorer Finds New Way to Orient

NASA reports that 95% successful mission by Explorer VIII has also yielded best data yet on micrometeoroid risk

by Hal Gettings

DATA from *Explorer VIII* has provided NASA scientists with some unexpected dividends.

Preliminary analysis of data from the satellite has uncovered a new way to orient a spacecraft without the use of optics and has contributed the most significant information to date on micrometeroid impacts in space.

In addition, all other experiments carried by the satellite—with the exception of one—yielded satisfactory results. All in all, NASA revealed at a press conference last week, the mission was 95% successful.

Explorer VIII was launched Nov. 3, 1960, aboard a *Juno II*, with an expected useful lifetime of two to three months. It ceased transmissions on Dec. 27 after over 1300 hours in orbit. Data from the satellite filled more than 700 miles of magnetic tape. Final analysis of this information will not be completed for six months or more.

Discovery of the new method of spacecraft orientation came from "current traps," or "collectors" on the satellite. These traps capture and measure charged particles—ions and/or electrons—by means of the current they generate in an attached circuit. Study of these measurements showed that the traps functioned effectively as angle-of-attack meters.

In other words, the number of particles captured was directly related to the direction the collectors were facing. A trap facing the direction of travel, for example, would collect a maximum number of particles; one on the opposite side of the vehicle would collect few or none. Consequently, a direct reading of the spacecraft's orientation can be deduced from this information.

Although it is not as accurate as optical methods for orientation determination, NASA scientists feel the new technique has many advantages over optics and will be valuable in many applications.

One of the principal disadvantages of optical methods is the fact that the light source—sun, stars, or earth, for instance—is not always visible to the satellite. Since an orbiting space vehicle spends some time in the earth's shadow, the sun and specific stars are hidden for definite periods. Systems which depend on the earth's illumination suffer from the limitation of uneven illumination, particularly when the twilight zone is in view.

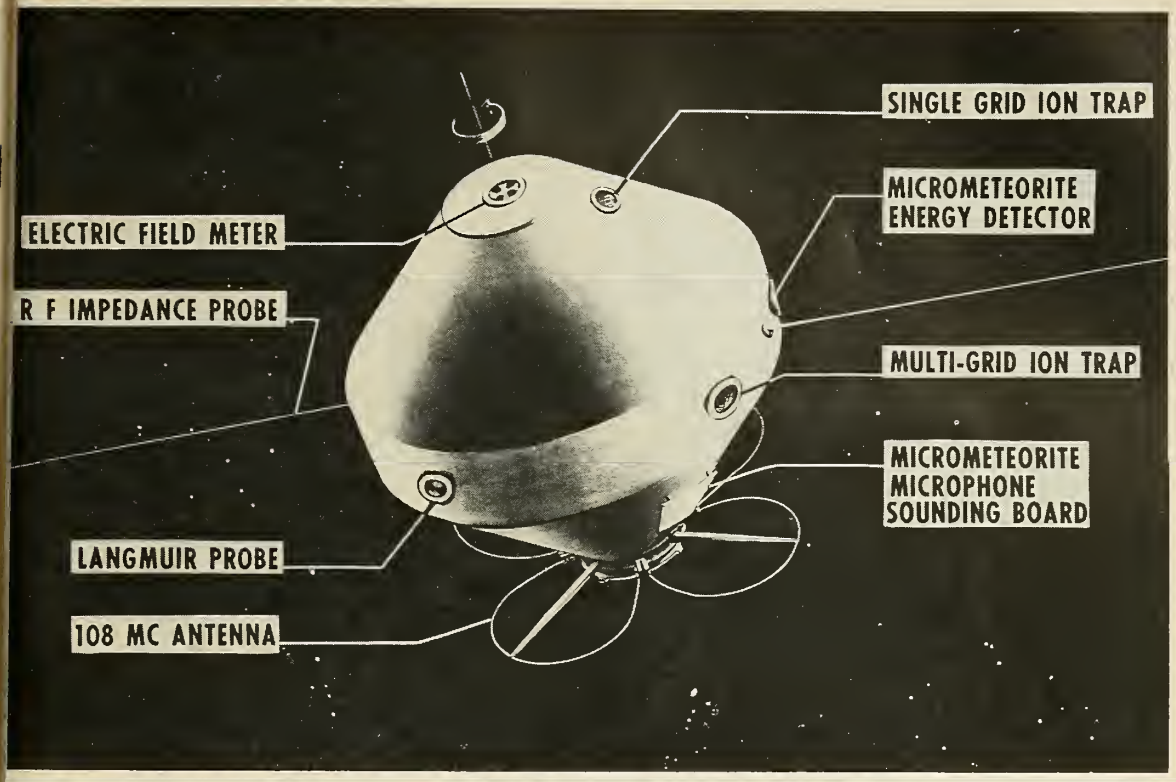
In addition to orientation information, NASA says, the technique could be used to determine and monitor the vehicle's spin rate and to aim cameras, telescopes and other instrumentation.

The current traps in *Explorer VIII* were carried for the sole purpose of obtaining information about ion and electron densities in the earth's atmosphere. It was not until after the satellite was in orbit that it was realized that they functioned as orientation sensors.

The traps themselves are not a new development; they have been used in previous experiments. Basically, they are somewhat similar to a conventional vacuum tube without an envelope. Wire grids exposed to the atmosphere are biased to allow the passage of either positive or negative particles (ions or electrons). The current set up in an at-



INSTRUMENT COLUMN in Explorer VIII has 20 modules containing transmitter, command receiver, amplifiers, counters, telemeter and other electronic equipment.



tached circuit by their passage and collection then provides a direct measurement of the particles collected.

• **Micrometeoriod information**—NASA scientists feel that the information on space dust particles obtained by *Explorer VIII* is particularly significant. For the first time, a large enough number of particle impacts are being obtained to provide the beginnings of a definite picture of the number and mass of these particles.

Explorer VIII data, correlated with that from earlier experiments with *Vanguard III*, provided several thousand micrometeoroid impact events. All previous measurements made by rockets and satellites totaled considerably less than one thousand.

Although information about the potential hazards of these micrometeoroids to spacecraft is still somewhat sketchy, NASA scientists are beginning to talk hopefully about the possibility of significantly reducing the shielding requirements of space vehicles—perhaps by a factor of ten or more. They are hoping that *S-55*—the first satellite devoted exclusively to micrometeoroid measurements (M/R, June 12)—will produce enough data to further substantiate their hypothesis.

Explorer VIII carried two impact sensors: a "sounding board" and a photomultiplier tube covered by a thin opaque film of aluminum.

The micrometeoroid experiment in *Explorer VIII* also appeared to back up an observation made with *Vanguard III* as to the makeup of major meteor streams. Contrary to some opinion, small particles apparently do exist in these streams. *Vanguard III*, in November, 1959, measured a large number of these particles in a period of about 70 hours. *Explorer VIII* encountered a similar stream in November, 1960, and indications are that small particles were again present. A solar flare at this time, however, made the data extremely difficult to retrieve. Another stream occurred in December, 1960, but information from *Explorer VIII* during this period has not yet been analyzed.

• **Other results**—*Explorer VIII* carried a total of ten experiments. Two, as mentioned, were designed to study the characteristics of interplanetary dust particles. Five were aimed at a study of the ionosphere. Three experiments were used to determine the characteristics of an ionized cloud that forms around a satellite due to its interaction with the ionosphere.

The five ionosphere experiments were entirely new and were conceived by Goddard scientists. Four of these used the current traps to count charged particles and measure the chemical constituents of space. The fifth, a radio-frequency impedance probe, counted the number of electrons surrounding the satellite by means of an antenna-matching technique.

The chemical experiment revealed that oxygen is the main constituent of space in the lower-altitude region (up to about 650 mi.) through which the satellite flew. Indications are that the sun produces the oxygen ions which drift upward to higher altitude.

Explorer VIII provided the first experimental measurement of the ionized cloud that forms around spacecraft. This cloud is thought to cause an electrical drag which can shorten the orbital life of a satellite. Data from *Explorer VIII* will provide the basis for a theoretical equation to determine the effects of drag.

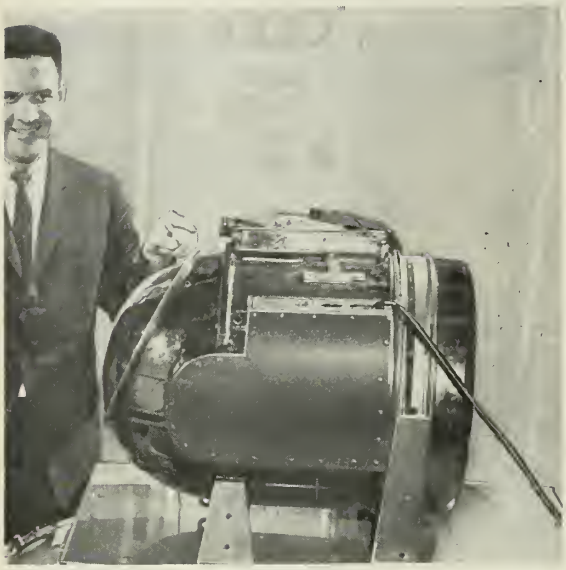
Also, the ionized cloud has an effect on the radar cross-section of a satellite, making it appear larger than its physical size.

Measurements from the experiment indicated that the cloud extends out from the vehicle a distance roughly equal to the vehicle's radius. Effectively, it increases its electrical dimension by a factor of two.

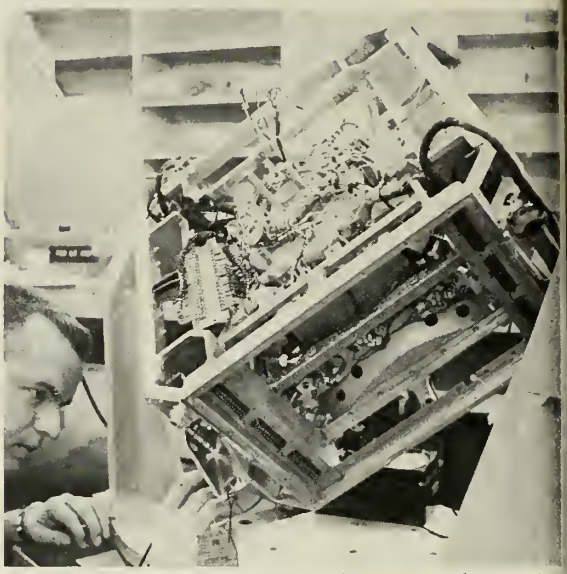
It was found that the cloud is formed mostly of positive ions in front of the satellite and of negative electrons in its wake.

The ionosphere experiments also showed that the effect of solar disturbances on radio propagation was confined mostly to the lower ionosphere. The researchers found that the upper ionosphere was relatively undisturbed by solar activity. ⌗

Titan II Guidance Due to Fly Soon



TITAN II ALL-INERTIAL guidance system has passed all environmental tests, including four rocket sled tests at Holloman AFB. "Under-200-lb." Inertial Measurement Unit (left) and



90-lb. Missile Guidance Computer (right) comprise the complete missileborne system—due for flight test soon in a Titan I vehicle. AC Spark Plug is prime contractor.

FIRST FLIGHT TEST of the *Titan II* all-inertial guidance system, riding on a *Titan I* missile, is expected soon.

This and successive test firings are intended to assure that the guidance system will be ready for the first *Titan II* launch scheduled for late 1961.

Prime contract for the complete guidance package was awarded to AC Spark Plug Division of General Motors Corp. by the Air Force in April, 1959. Value of the contract was $84 million.

Besides its overall system responsibility, AC Spark Plug developed the stable platform and associated electronics.

International Business Machines Corporation, under a subcontract, developed the digital missileborne computer and the complete guidance checkout and launch equipment.

Titan II inertial guidance will be capable of directing a nuclear warhead to any one of a number of targets without any last-minute instructions. The only initiating command is the particular trajectory selected by the firing officer from the guidance computer memory.

If necessary, however, new target data also can be fed into guidance memory just before launch.

• **Major subsystems**—The *Titan II* guidance platform is a second-generation version of the Skipper inertial guidance developed by Massachusetts Institute of Technology for the Air Force.

The platform is a fluid-temperature-controlled three-gyro system. With its integral electronics package, the complete Inertial Measurement Unit (IMU) weighs under 200 lbs. (See M/R, Feb. 27, 1961, p. 33.)

Developed at the IBM Space Guidance Center in Owego, N.Y., the Missile Guidance Computer (MGC) represents over 5 years of technological evolution in drum-type solid-state computers.

Details of the *Titan II* missileborne computer just released by the Air Force indicate that the highly advanced 90-lb. subsystem has passed unusually severe environmental tests. These included centrifuge tests at 5-g on three separate axes, launch-shock simulations of stress up to 20-g, and shock-drop tests at 100-g.

Hard-mounted production models of the complete subsystem were subjected to 3-g force on a sinusoidal curve—first in one direction, then in the other.

Key unit in the guidance computer is the miniature magnetic memory drum. Operated at 6000 rpm, the stainless steel drum consists of a thin shell having a magnetic-film surface.

Data, carried along 57 tracks, are stored or retrieved with many of the 82 air-floated magnetic heads. Some of the supporting arms carry two magnetic heads, in line, to facilitate rapid computation.

The frictionless heads are suspended by an air cushion 0.0001 in. thick.

All circuit and logic-element connections in the computer (and IMU) are welded; all logic circuitry is encapsulated.

• **Operation**—The checkout and launch set will monitor the entire guidance system in the siloed missile. Continuous evaluation of gyros and accelerometers maintains *Titan II* in a state of readiness.

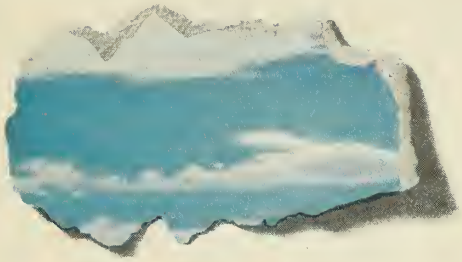
The checkout system also provides automatic malfunction detection and isolation of defective modules.

Initial platform alignment is optical. Following target selection and launch, the guidance system maintains attitude control. Gyro stabilization is conventional.

The platform accelerometers sense linear acceleration, convert this into velocity increments and emanate digital velocity data to the guidance computer.

Digital outputs are derived from an optisyn—a photoelectric transducer incorporated within each accelerometer. For attitude control, an optisyn also is mounted on each gimbal axis for digital outputs to the computer.

The computer is a serial, binary, whole-word system combining the optisyn data with the stored target data and platform characteristic data. It continually supplies steering signals for yaw, pitch, and roll to the missile control system, and a series of discrete commands for engine cutoff. ❖



Problem for Skybolt: Where is this patch of sky?

To calculate its trajectory to target, Skybolt air-launched ballistic missile will have to know precisely where it is at any given moment, day or night. This problem is neatly solved by the star tracking capability of its Astronertial guidance system, which can provide an instantaneous fix on any piece of sky the mother plane passes through. When Skybolt is operational, the guidance system will put it into a ballistic trajectory after launch, to deliver the warhead on target up to 1000 miles away.

This versatile stellar-monitored inertial guidance system is being designed and built by Nortronics for the USAF-Douglas Skybolt, now under development.

NORTRONICS
A DIVISION OF
NORTHROP

Honeywell Aero... for the best of both





CLIMATE FOR CREATIVITY—Honeywell Aero is now producing inertial platforms for the Polaris Missile. In addition Aero Division Engineers have created an Electrically Suspended Gyro for use on Polaris launching submarines, which is capable of providing accuracies never before achieved in an inertial navigation system. This project is typical of the creative concepts and ideas which are being evolved and further developed into working hardware at Honeywell Aero. We invite you to share in this creative atmosphere where there is ample opportunity for a man of imagination, drive and talents to grow in professional stature and have his accomplishments recognized and rewarded.

CLIMATE FOR ENJOYMENT—Spectator or participant, you'll find whatever sport interests you in the Minneapolis area. For example, this is the heart of America's finest fresh water fishing country. At the end of a busy day or week you can angle for pike, bass, trout, or scrappy panfish in the more than 80 lakes within 25 miles of Minneapolis. Fishing is just one aspect of the many recreational, educational, social, and cultural pleasures you and your family will enjoy when you work at Honeywell's Aeronautical Division in Minneapolis. For information on specific openings, write: Mr. Clyde Hanson, Technical Director, Aeronautical Division, 2648 Ridgway Road, Minneapolis 40, Minn.

Honeywell

H Military Products Group

To explore professional opportunities in other Honeywell operations, coast to coast, send your application in confidence to: Mr. H. T. Eckstrom, Honeywell, Minneapolis 8, Minn. All qualified applicants will receive consideration for employment without regard to race, creed, color, or national origin.

Circle No. 5 on Subscriber Service Card

Technical Countdown

ASTRONAUTICS

Anchor Man for Space Vehicles

Astro-technicians, like Archimedes, will need a place to stand in order to do any useful work in space. Studies at North American Aviation show that astronauts must be firmly anchored whenever they use tools or other devices requiring physical force. Tests with unanchored men on an air-bearing platform revealed that reaction from physical movements in weightless space would make effective work almost impossible.

Magnetism vs. Weather

Fluctuation of the earth's magnetic field and its possible correlation with violent electrical storms is being studied at Sylvania Electric's Applied Research Lab. The effects of sun spots and solar flares on the magnetic field are also being investigated in the Air Force-funded study.

And More Weather Research

Remote determination of weather variables at distances up to 25 miles is now reported possible through use of new radiometer techniques developed by Armour Research Foundation. Radiometers would be used to obtain data for computer analysis to determine temperature, relative humidity, air pressure, and wind direction and speed.

ADVANCED MATERIALS

Superconductor Magnets Nearer

Superconductor magnets may be produced as a result of the development of a malleable Nb-Zr cold-worked alloy by Atomics International Division of North American Aviation, Inc. Wire drawn from the alloy has conducted 100,000 amps at −452°F in a magnetic field of 30,000 gauss. It is expected to retain its characteristics in substantially higher magnetic fields. The vast potential of superconducting magnets includes space and controlled thermonuclear uses.

Cryogenic Facility Completed

Janitrol Aircraft Division is operating a newly completed cryogenic testing facility. The installation includes a 500-gal. test Dewar, a 5000-gal. supply Dewar and associated vacuum-jacketed transfer system, together with complete instrumentation for recording temperatures, pressures, flow rates and vapor quality determination.

Electron-Melted Metals Go Commercial

An electron-beam furnace utilizing the remote gun principle is in operation at National Research Corp.'s Metals Division. Tantalum and tantalum alloys will be the first commercial products. The unit, also capable of drip-melting pressed bars, is under license from Stauffer Chemical.

Beryllium Oxide Fiber Work Extended

National Beryllia Corp. will work on laboratory synthesis of beryllium oxide fibers for ultra-high-temperature structural materials under a 12-month contract from Materials Central, Aeronautical Systems Div., USAF. Preliminary studies showed fiber tensile strengths up to 2 million psi. The potential modulus of these fibers could exceed 50 million psi.

One-Armed Bandit at Work

Thiokol's Elkton Div. is using a one-armed robot to carry experimental motors and propellant compounds from laboratory to testing areas. The claw-like appendage can turn continuously in either direction, screwing nozzles on engines with ease. The robot moves on small, remotely controlled treads.

ELECTRONICS

New Delay Line Under Development

Martin Company's Electronics Division is using superconducting-metal techniques to build an X-band delay line for the Air Force. Providing a 20-microsecond delay, the unit will employ a small drum carrying coaxial wire 15,000 ft. long x 8 mils in diameter (see p. 40).

Advanced Camera to be Built

A unique high-speed camera capable of recording four separate images simultaneously or in sequence is being built under a 2-month NASA contract recently awarded. Abtronics, Inc. will develop the system, which will have framing rates from 1-10,000 microseconds. The 45-lb. camera will be used primarily for recording electrical-discharge forming operations and other explosive reactions.

Gyro Stands Air-Supported

New gyro test stands to be built for Air Force's Holloman Missile Development Center by Dunn Engineering represent a "breakthrough" in inertial test gear, the developers say. The precision turntables, according to Dunn, achieve accuracies heretofore unattainable by using "air-lubricated" bearings. The technique eliminates degrading influences of flutter and friction.

Inertial Guidance Test Standards Due

The Air Force has contracted with a group of companies for design studies of automatic, standardized checkout equipment for inertial guidance systems. Specifically, standardization will be aimed at checkout and test for guidance in five missiles: *Atlas, Titan, Skybolt, Minuteman,* and *Hound Dog*. The undertaking also creates another acronym —VATE, for Versatile Automatic Test Equipment.

Thermionic Converter Under Construction

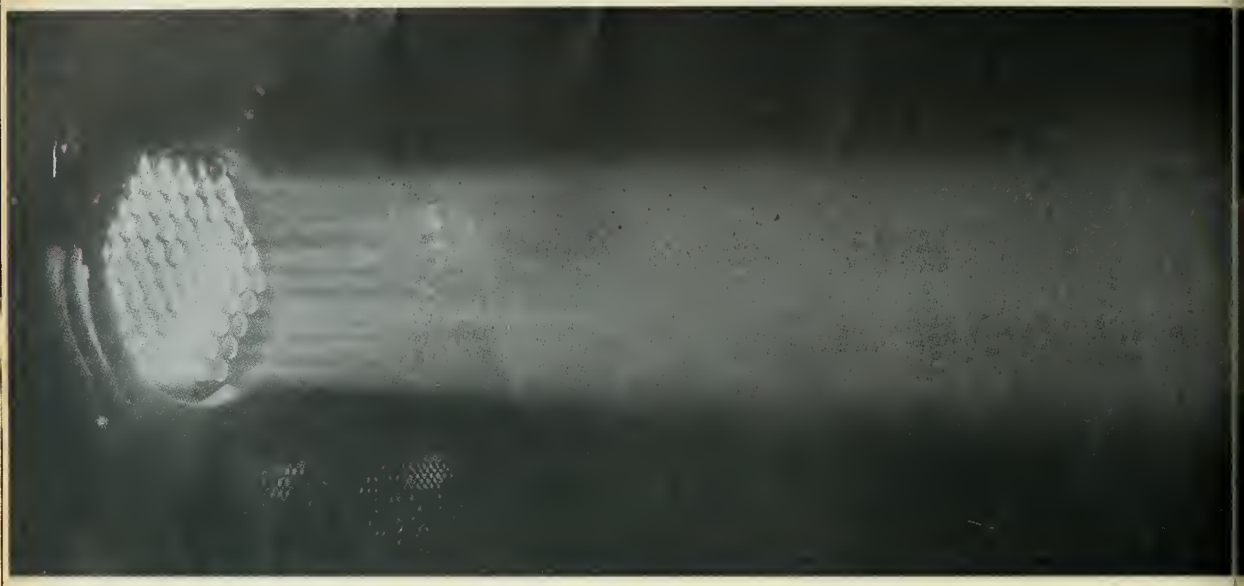
A solar-thermionic converter system, designed to generate 135 watts, will be developed by Electro-Optical Systems for NASA's *Mariner*-class spacecraft. The 25-lb. unit, called SET (Solar Energy Thermionic Conversion System), will employ several cesium-vapor thermionic diodes for the energy conversion. A 5-ft.-diameter solar concentrator will direct radiation to a cavity housing the diode array. First model is due in six months.

ASW ENGINEERING

Bermuda or Bust

Each of the major oceanographic or ASW research programs (TENOC, AUTEC, Artemis, and Trident) is scheduled to have its scientists and technicians on and about Bermuda during the next few months. Said one scientist, "If only half of those planning to hit Bermuda this summer actually arrive, it will still be an impossible situation."

Air Force Gets Its First Ion Engine



Company is hard at work on 61-beam-plus cesium engines and has achieved about 3.2 millipounds of thrust; more efficiency is goal

by Frank G. McGuire

PASADENA, CALIF.—The first in a series of ion engines designed for operation in space has been delivered to the Air Force Aeronautical Systems Division by Electro-Optical Systems, Inc.

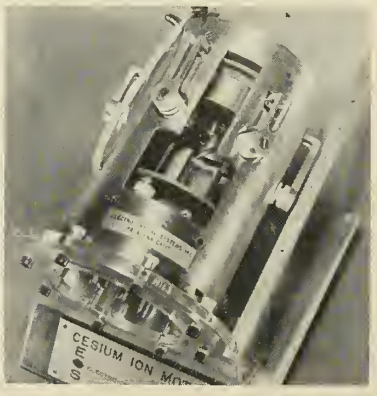
On-time delivery of the unit was made as ASD extended its contract with the company for additional basic research and development—as well as a parallel R&D program for further work on components.

The delivered demonstration engine is expected to be followed by other engines of various types now under development by a number of firms for AF and NASA. Both government agencies are also conducting in-house development programs.

The EOS unit utilizes a multiple neutralized beam produced by ionization of cesium, but all details of performance, applications and hardware are tightly classified.

The contract for the engine, awarded in February, 1960, was believed at that time to call for thrust levels of 0.1 lb. (M/R, Feb. 1, 1960, p. 24).

• **Bigger and better**—EOS, which won the contract in competition with





LEFT: *Three-millipound-thrust EOS ion engine model of type that could be used for satellite vernier control applications.*

MIDDLE: *Ionizer assembly consists of porous tungsten discs approximately a quarter of an inch apart. Ions formed by passing cesium vapor through these discs are accelerated by electrodes and ejected from the rear of the rocket.*

RIGHT: *Ion motor structure shows exit electrodes (left) and mountings. Behind exit electrodes are accelerating electrodes and porous tungsten ionizer.*

OS Aims for Bigger, Better Units

Rocketdyne, Aerojet-General, General Electric, Lockheed, Avco and other companies, is currently working on larger and more sophisticated designs.

The company has confirmed that it is working on engines with as many as 61 beams, and unconfirmed reports put the figure even higher.

About 3.2 millipounds of thrust have been gained with the 61-beam engine, which has operated for 170 consecutive hours without failure. Specific impulse is 5000 to 8000 seconds with efficiencies up to 65%.

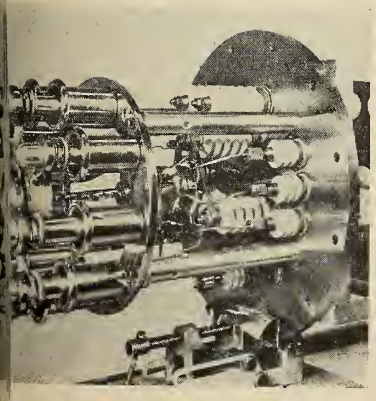
EOS is trying to raise its efficiency level with the engines at lower power consumption, while maintaining high specific impulse.

Design of the basic multiple-beam units contains a number of individual cesium ionizing sources, closely spaced in an array with a common plane. The rear-fed porous tungsten ionizers are disc-shaped and line up with apertures located coaxially in the accelerating/decelerating electrodes.

Thus far, engines have achieved a power to thrust ratio of about 275 kw/lb. in the 5000-8000 second specific impulse range.

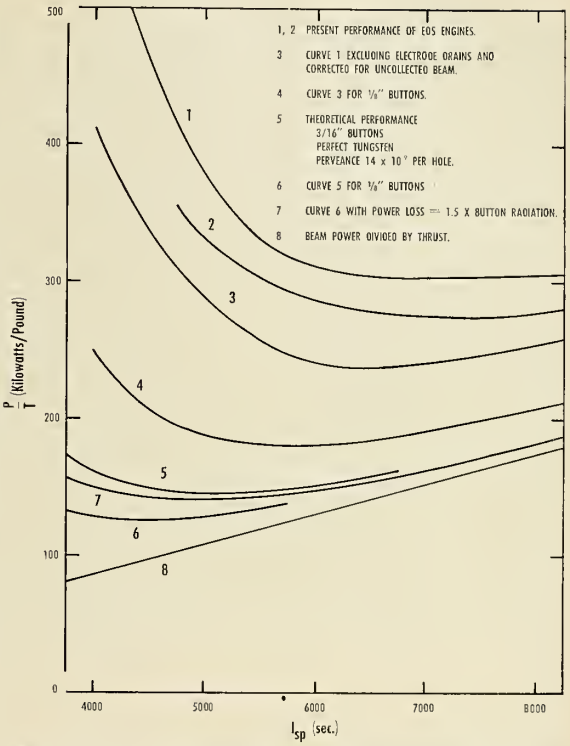
Laboratory runs have been made for measurement of thrust, power, and current carried by the ion beam, as well as engine efflux of neutral cesium. Erosion due to ion bombardment has cut the life span of the accelerating electrodes, and this major problem is believed traceable to the porous tungsten used for ionization.

Other laboratory instrumentation includes an electron beam probe to show any deviation from charge neutrality of the beam, and other equipment for determination of voltage, current, power and temperature of components.



• System description — The feed system for this 61-beam unit was based simply on use of vapor pressure from the liquid cesium to provide a flow from the reservoir to the ionizer manifold and through the porous tungsten buttons brazed into the manifold.

After ionization, the cesium is accelerated in a beam by the electrode structure. A decelerating action is taken after the beam has been accelerated through a high potential so that the engine can operate at a favorable current density.



GRAPH SHOWS how Electro-Optical is working toward increasing efficiency of engines. Reducing button size is a major factor.

Dr. A. T. Forrester, head of the Ion Propulsion Laboratory at EOS, emphasized the role of the ionizing unit and its associated structural components in contributing to efficient operation.

A molybdenum plate is used as a base for brazing the porous tungsten buttons, the plate then being brazed into a molybdenum crucible previously milled to provide built-in channels for propellant passage. The channels are precisely patterned to provide uniform flow to each ionizing button, simultaneously allowing heat transfer paths from the rear of the crucible to the buttons.

During the engine's operation, the buttons are heated by conduction from a sheathed heater brazed to the crucible. The crucible's edges and rear surfaces are heavily shielded from heat.

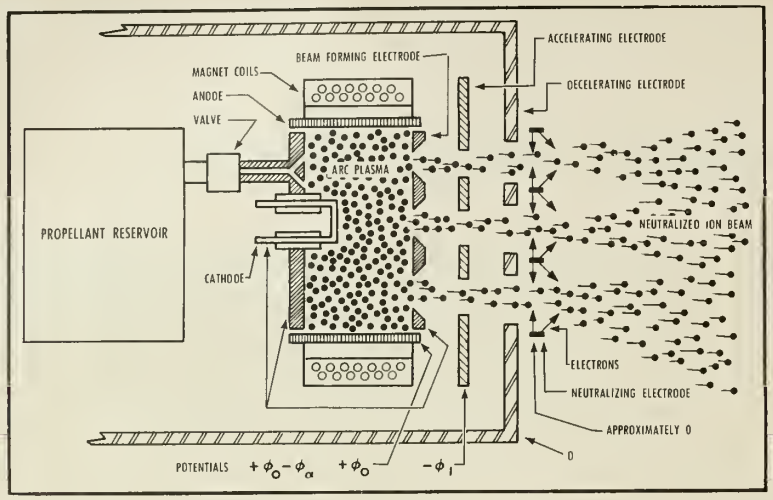
About 45% of the overall ionizer surface area is actually tungsten; the remainder is molybdenum, which does not produce ions, but radiates. The porous tungsten buttons are spaced closely in a hexagonal array, with about .252 in. between centers of the 3/16-in.-diam. buttons.

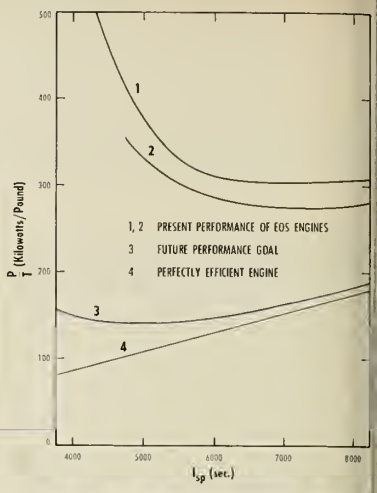
The surface area between the buttons is coated with tantalum shield to protect against heat, then covered with molybdenum. The final surface of molybdenum acts as an electrode to form the beams coming from the buttons and provide focusing sufficient to overcome space charge expansion.

Beam neutralization is achieved by drawing electrons into the exhaust from a thermionic emitter, as the beams pass through the electrode apertures.

Due to variations in permeability of commercially available porous tungsten, the buttons with low permeability are placed near the center of the array, and those with high permeability toward the outside, so that the variations in cesium pressure will partially compensate for this.

An advantage of having the heat-shielded electrode which forms the beam initially from the ionizer surface is that low ionization occurs with





LEFT: Schematic of the cesium ion engine. EOS uses liquefied cesium for its tests; normally, solid-state propellant would be employed. RIGHT: Power-to-thrust ratio chart shows how EOS future performance goal nears perfect efficiency.

cesium atoms contacting it, and unfocused ions produced between buttons would otherwise strike the electrodes and cause erosion.

Both electrodes, for acccleration and deceleration, are made of copper in disc shape, with drilled apertures. The accelerating electrode has holes slightly smaller than the ionizing buttons, and the decelerating electrode holes are slightly larger than the button.

Ionizer and electrode components are mounted on three eccentric insulated posts to form the basis of the engine. The eccentricity allows the laboratory personnel to rotate components and thereby make adjustments.

Propellant is kept in a container mounted outside the vacuum test chamber and is liquefied when required, shifted from the vessel through a sight glass, measured, piped into the engine boiler, where it is then vaporized and allowed to feed into the ionizer. Normally, the propellant would be in a solid state, but EOS is utilizing liquefied cesium for tests.

After the 170-hour endurance run, EOS scientists extrapolated data and examined equipment used, determining that another 50 hours of operation was left in the engine before electrode erosion would have caused a shutdown. The buttons themselves showed no deterioration after 242 hours of operation.

Forrester said engine performance can be greatly enhanced by improving ionizer heat shields, achieving greater uniformity in tungsten porosity, eliminating electrode drains, decreasing ionizing button size from 3/16 in. to 1/8 in. while maintaining the same current per aperture, and similar refinements and advances.

Military Electronics Get Annual Scrutiny

INDUSTRY will get a close look at new developments and future requirements in defense electronics at the annual Convention on Military Electronics in Washington, D.C., June 26-28.

An impressive array of military leaders and top scientists will discuss subjects ranging from underwater surveillance to missile defense.

The kickoff panel—Trends in Weapon System Development—will be chaired by John H. Rubel, Deputy Director of DOD Research and Engineering. Assistant secretaries of the Army, Navy and Air Force will participate.

Rear Adm. Frank Virden, Director of Naval Communications, will be the principal speaker at the keynote luncheon on Monday, June 26. Dr. Edward G. Witting, Deputy Assistant Secretary of the Army (R&D) and chairman of the IRE Professional Group on Military Electronics, sponsoring group, will serve as master of ceremonies.

More than 100 papers on military electronics will be presented during technical sessions. In addition to 15 unclassified sessions, six classified sessions sponsored by Air Force Systems Command are included.

Topics and moderators for the classified sessions include: command and control in the military structure, Dr. W. O. Baker, v-p, Bell Telephone Labs; oceanic surveillance technology, Dr. R. O. Burns, Director, Technical Analysis and Advisory Group, Office of Chief of Naval Operations; satellite communications, Brig. Gen. George P. Sampson, director of operations, Defense Communication Agency; ballistic missile defense, Dr. A. Rubenstein, Director of ARPA's Project *Defender*.

Six state-of-the-art sessions, including invited tutorial papers, will highlight the unclassified technical program. Topics and moderators: plasma physics, Dr. Walter K. Khan, Brooklyn Polytechnic Institute; radio and radar astronomy, Dr. John P. Hagen, NASA; computer technology, Dr. Samuel N. Alexander, National Bureau of Standards; space physics, Dr. Robert Jastrow, NASA; modern low-noise receiving systems Dr. Robert Adler, v-p, Zenith Radio Corp.; aerospace technology, Dr. Charles T. Morrow, Aerospace Corp.

Topics of other unclassified sessions include management and packaging techniques, instrumentation, communications (two sessions), radar (two sessions), reliability, military systems data handling, and electron devices.

NASA Speeds Up Drive To Recruit 3300 Persons

National Aeronautics and Space Administration field centers have been directed to step up recruiting efforts to fill present vacancies and meet new manpower requirements anticipated for the expanded U.S. space exploration program.

Earlier reports (M/R, June 5) indicated the space agency would need an additional 3300 people to meet the accelerated program outlined by President Kennedy.

Models Aided Titan II Silo Shot

Low-cost two-year testing program by STL/Aerojet was instrumental in successful firing of full-scale bird

by John W. Herrick

SUCCESS of the recent launch of a modified *Titan I* test vehicle from a *Titan II* Silo Launch Test Facility at Vandenberg AFB came as no surprise.

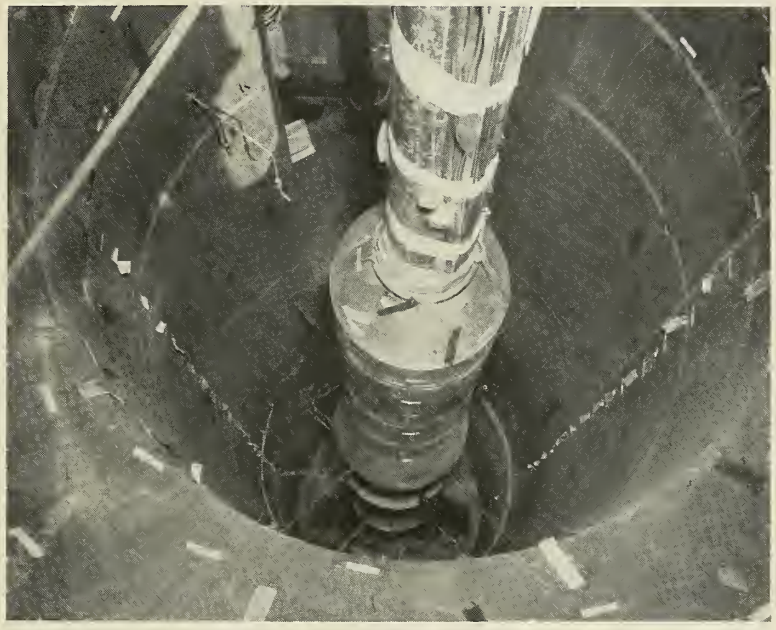
The launch merely verified results of a model test program jointly conducted by Space Technology Laboratories, Inc.—systems engineers and technical directors for the *Titan* program, and Aerojet-General. The tests—begun two years ago—were carried out in a one-sixth-scale *Titan* ducted launcher at Aerojet's Azusa, Calif., facilities.

Questions unique to a silo-type *Titan* launch were answered by the STL/AG effort at a fraction of the usual cost: according to project engineers, $1.3 million—less than the cost of one full-size ICBM launch—was spent on the test program from the first firing June 6, 1959, until January of this year. The figure includes $100,000 for special silo-type test stands at Aerojet.

Thirty-six firings of the model provided the basic information on pressure pulses, temperatures, acoustics and duct lining concepts needed to guide design of full-scale *Titan II* silos.

When the full-scale bird was launched at Vandenberg on May 3, the result was a program director's dream, STL reported. Large quantities of valuable data were obtained from near-perfect operation of instruments in the test vehicle and SLTF installations, verifying earlier decisions and evaluations based upon the model test program.

The stand consisted of a three-tube arrangement—one missile tube between two exhaust ducts—connected at the bottom by a W-shaped flame deflector. Exhaust gases were conducted through the ducts to a simulated ground plane of steel plate. Two additional mounts were incorporated in the missile launch tube at selected positions above the static position to investigate effects related to a rising vehicle.



SCALE-MODEL SILO and miniature Titan were built and tested at Azusa plant. A 30-ft.-diam, platform midway up the tower simulated ground level of operational silos.

• **Acoustics predictions correct**—Ray Flynn, STL program manager, told M/R that the model program verified an acoustic scaling law developed by Bolt, Beranek and Newman, sound consultants engaged when acoustics grew into a major problem.

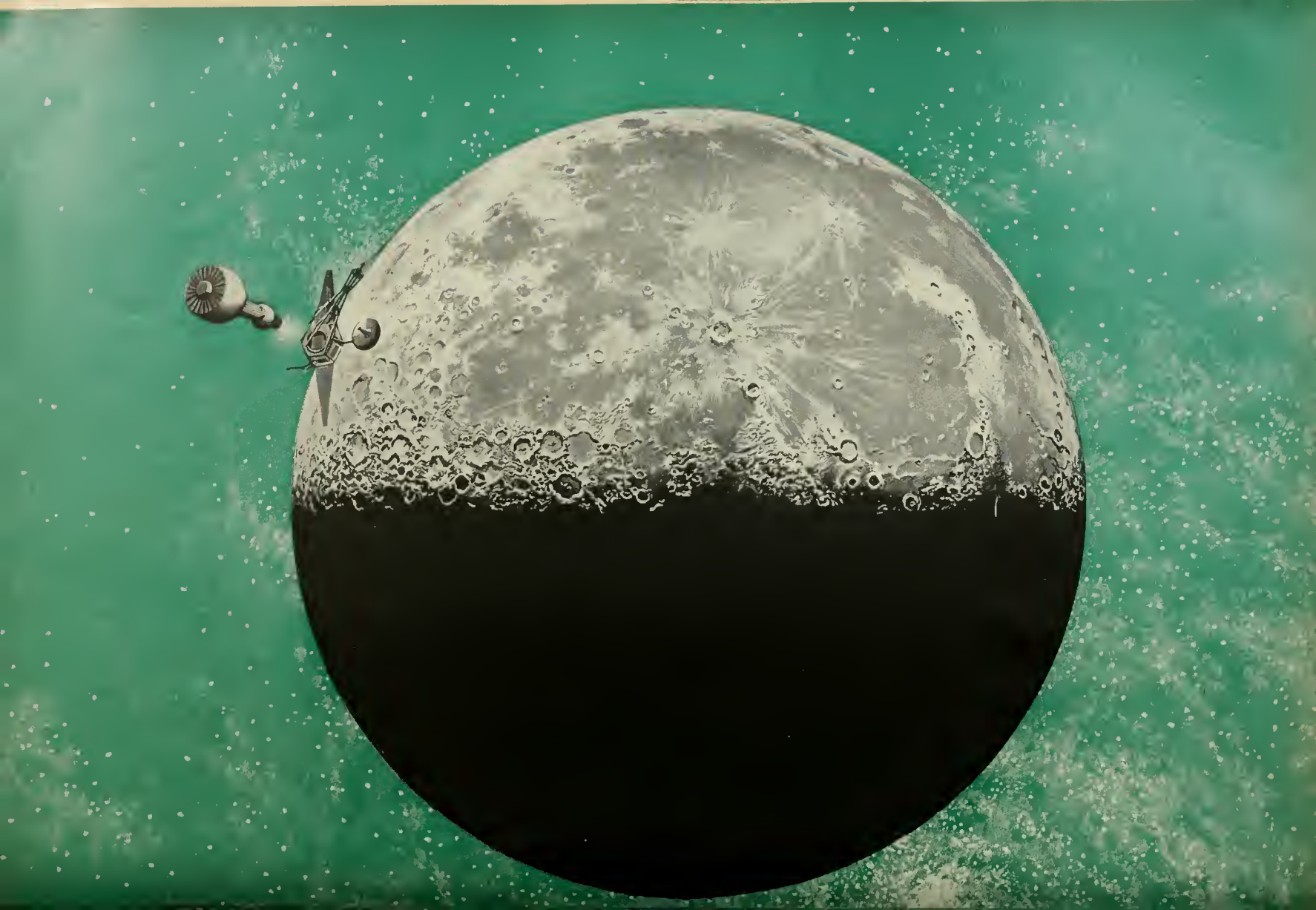
The scaling law had predicted an acoustic environment of 148 decibels on the emerged skin when the full-scale *Titan* had lifted about 30% out of the silo. Data from the recent full-scale test now supports this value and also validates a predicted maximum level of 158 decibels at the booster engine compartment.

Solving all the problems associated with sound-induced vibrations required a great amount of team effort. It was discovered during the model test program that the decibel level measured at vital areas on the model's surface increased as the twin engine nozzles were positioned higher in the silo. When the *Titan* model was raised to the position where the guidance compartment was exposed above the ground plane, acoustic energy reached a peak of 163 decibels.

Analysis of this unacceptable condition disclosed that the acoustical energy spreading outward from the top opening of each exhaust duct was augmenting energy from the main opening. After considering all possible remedial approaches believed to be practical, it was decided to moderate the acoustic energy by lining the entire duct with a fiberglass-type sound-absorbent material. In keeping with the scale tests, the special insulating panels were shaved and pressed to again simulate the one-sixth-scale model as accurately as possible.

Need for acoustic lining in the operational configuration was proven when model tests showed a measured 13% drop in decibels at the ground plane after the lining had been installed. Further tests also checked out liner design, predicted temperatures and calculations on air entrainment.

• **Pressure pulse**—One problem encountered in the test program was a severe pressure pulse in the bottom of the silo and exhaust ducts at ignition. Nearly all liquid-propellant engines produce a "concussion" during the ignition phase, but within the confined area of a silo duct the energy becomes intolerable. It was also considered that the peculiarities of a full-scale *Titan II* ignition would aggravate this condition, and an





UNAR PROBE

The moon — lacking an erosive atmosphere — may hold the key to the history of the solar system. Because of this lack of atmosphere, oceans, and wind, lunar explorations may help solve fundamental, universal questions

Logically, the moon will be the first objective in the exploration of space. Initially the moon itself will be photographed and instrumented; then manned observation stations will be established for astronomical and meteorological purposes. In time, the moon will serve as an intermediate station enroute to other planets — step by step into infinite space.

The National Aeronautics and Space Administration's Lunar Program will utilize Lockheed's AGENA B satellite to play a significant part in forthcoming lunar explorations — as well as a host of other scientific space missions. The NASA lunar launch in 1961-62 will utilize the highly reliable Lockheed AGENA as second stage to carry the RANGER spacecraft. The AGENA will provide the extremely critical guidance and controls necessary to place the RANGER on the required lunar impact trajectory.

The lunar probe application demonstrates the versatility, reliability and success of the AGENA vehicle in Lockheed's satellite and spacecraft programs. Developed for the Air Force for use in the DISCOVERER program, the AGENA also is utilized in the MIDAS missile defense alarm system. Noted for a record of outstanding accomplishments, the AGENA is credited with being the first to be placed on a polar orbit; first to achieve a precise, predicted and nearly circular orbit; first to attain attitude control on orbit; first to eject a reentry capsule which was successfully recovered. The AGENA can be modified for a variety of missions such as navigation, geophysical investigations, long-range communications and deep space probes.

Lockheed's capability in satellites and spacecraft, manifested by such an achievement as the AGENA, encompasses the entire field. It includes current and long-range programs such as interplanetary probes, global and space communication systems, and manned space travel.

Engineers and Scientists: The accomplishment of such programs offers challenging opportunities to engineers and scientists in the research, design, development, test and operation phases of these programs. If you are experienced in work related to any of the above areas, you are invited to write: Research and Development Staff, Dept. M-29A 962 W. El Camino Real, Sunnyvale, California. U.S. citizenship or existing Department of Defense industrial security clearance required. All qualified applicants will receive consideration for employment without regard to race, creed, color or national origin.



Lockheed / **MISSILES AND SPACE DIVISION**

Systems Manager for the Navy POLARIS FBM and the Air Force AGENA Satellite in the DISCOVERER and MIDAS Programs

SUNNYVALE, PALO ALTO, VAN NUYS, SANTA CRUZ, SANTA MARIA, CALIFORNIA
CAPE CANAVERAL, FLORIDA • HAWAII



FIRING OF 1/6TH-SCALE MODEL at night. Engine exhaust can be seen exiting from either side of W-shaped flame deflector.



TECHNICIANS PREPARE Titan model for testing in sma silo. Underground operational missile silos will be 139 feet long

accidental accumulation of unburned propellant under these conditions would be a serious hazard.

In the model test setup, it was discovered that an increase of the water injected into the exhaust region to a flow of 12,000 gallons per minute suppressed the pressure pulse to an acceptable level. The four streams of water directed against the exhaust stream have little effect in suppressing acoustic energy during static firing. But when the missile starts to rise, the exhaust stream moves upward from the deluge plane, thus changing the water role to that of coolant. No water was used in the full-scale Vandenberg shot, however.

For the model tests, conducted by Aerojet's Advanced Research Division, project manager Robert Loya selected modified thrust chambers taken from the *Nike-Ajax* production line. In normal use, the uncooled chambers are operated at 15,000 lbs. thrust. For the *Titan II* test program, the two thrust chambers were fired at 25,000 lbs. thrust each to achieve the one-sixth scale of 50,000 lbs. thrust. The primary modification was to make the injector system capable of handling the increased fuel flow. (It is interesting to note that little difficulty was encountered with the system—indicating that the *Ajax* unit must be considerably over-designed.)

Tests were also made to determine *Titan II* operation on storable propellants as related to the design of operational ducted launchers. The last 13 firings of the test model were made on *Titan II* propellants, nitrogen tetroxide and 50/50 UDMH and hydrazine, and at scaled *Titan II* thrust.

- **Borrowing from British**—Studies made by the British in 1956, when they were considering a silo system for the *Blue Streak* missile, contributed substantially to early U.S. studies in ducted launchers for liquid rockets, according to *Titan* project engineers. The British first operated their scaled-down thrust chambers on cold gas, later shifted to hydrogen peroxide and kerosene and then Gamma rocket engine. Contributions were made by the British in the area of drift envelopes and air entrainment.

The drift envelope may be defined as the volume enclosed by a surface containing the outside of the missile body at its maximum probable radial displacement at all vertical stations from liftoff to the silo rim. The *Titan II* drift envelope resembles a water spout in configuration and is calculated by assuming the worst possible thrust misalignment, control system errors, launch stand misalignment, aerodynamic deflection and ground wind effects. The specified silo opening must provide the required clearance outside the drift envelope. The operational *Titan II* will lift out of a circular tube 25 ft. in diameter. The Vandenberg SLTF is an octagonal steel passage.

Calculation and test showed that 70% ducting, where the cross-section area of both exhaust ducts equalled 70% of the silo opening, provided the desired air entrainment for the test. During a firing of the twin boosters, the divided rocket exhaust stream pulls outside air down around the vehicle by aspiration.

The 'Sizing' Law

IN DEVELOPING the test model concept for Titan II, project engineers selected the model configuration by a "sizing" law based on the hypothesis that the momentum per square foot of exhaust-gas flow will be the same between rocket engines of similar design but of different size.

GIVEN: *Momentum of exhaust gas per square foot is equal for the model and the prototype engines.*

THEN: $\frac{\dot{m}V}{A}$ model $=$ $\frac{\dot{m}V}{A}$ prototype

Using $V_{model} = V_{prototype}$ and

$F = I_{sp} = \dot{m}$

I_{sp} of model $\neq I_{sp}$ of prototype

THEN: F/A of model $=$ F/A of prototype

Taking K $=$ L* of model / L* of prototype

THEN: K^2 $=$ F of model / F of prototype OR

K $=$ F of model / F of prototype

Where: $\dot{m}$ is the mass flow rate

V is the exhaust gas velocity

A is the nozzle throat area

F is the thrust

I_{sp} is the specific impulse

L* is the characteristic length

Space Dust Brought Back by Rocket

AZUSA, CALIF.—A unique trap has been lofted 102 miles above the New Mexico desert and recovered in what appears to be the first successful effort to capture extraterrestrial dust particles from a region above the earth's atmosphere.

Complete results of the June 6 experiment, in which the dust trap was recovered from the nose cone of an *Aerobee-Hi* sounding rocket, will not be known for several weeks, say scientists at the Air Force Cambridge Research Laboratories, directors of the program. Test slides must be thoroughly examined at the laboratories to determine what particles were brought back from space.

The AFCRL scientists will also attempt to find the kinetic energy and direction of the captured particles by studying 48 groups of stacked slides.

The importance of this test, and another micrometeorite sounding scheduled for June 21 from Eglin AFB, Fla., lies in the potential threat of these fine particles—measured in thousandths of a millimeter—to future manned space missions. The launching slated for the 21st will carry a payload of ultrasensitive microphones to a high altitude on the nose of a *Nike-Cajun* sounding rocket in a continuing effort to learn more about these lethal "dust bullets" traveling at 6.8 to 47.8 miles per second through the vacuum of space.

From the first sweep of the Aerojet-General space broom, AFCRL hopes to find a means for observing micrometeorites from ground stations. The present method of launching sounding rockets and satellites carrying micrometeorite instrumentation above the atmosphere is expensive and discontinuous. Researchers do not yet have sufficient information on space-originated particles settling on the surface of earth to distinguish them from dust of terrestrial origin.

• **Despin debut**—Another significant technical first was accomplished during the ascent of this Aerojet-General *Aerobee-Hi* vehicle from the launching tower at the Naval Ordnance Missile Test Facility, White Sands, N. M. A despin device was used for the first time on a sounding rocket to kill rotation of the payload. Previously the only application of despin systems had been on a few satellites.

Engineers in Aerojet's Spacecraft Division at Azusa, Calif., working with Nicholas T. Migdal, Project Engineer, designed the payload despinner, dubbed the Yoyo, to make sure that satisfactory mechanical operation of the dust traps would not be jeopardized by centrifugal forces.

When the boosted single-stage *Aerobee-Hi* rocket reached an altitude of approximately 40 miles (after burnout), an electronic device moved the nose cone skin forward, exposing four curved leaves that formed a sectioned cylinder. Within that enclosure nested four more curved leaves, also hinged at the bottom and also holding boxes containing the dust traps.

The next command signal initiated the Yoyo despinner at the same instant that the eight leaves were swung radially outward. Telemetry data shows that the spin was halted in .1 second, a rate much faster than expected. The dust-seeking leaves remained extended as the expended rocket continued to coast upward, on its momentum, to a zenith of 102 miles.



NOSE CONE of Aerobee-Hi sounding rocket moves forward to expose leaves

The cast aluminum boxes contained various arrangements of millipor filters, mylar films and plexiglass slides. The boxes on four leaves contained 48 triple-layer stacks of slides; a mylar top layer and middle piece with plexiglass at bottom. Two diametrically opposite boxes were kept closed to be used as control references in the laboratory. The remaining two leaves mounted mylar films and millipor filters.

When the rocket had dropped back to about 55 miles, the leaves were retracted, closing the eight boxes tightly against their lids in the center structure, and the skin slid down to its original position, sealing the payload section. At an altitude of around 50 miles, the nose cone was separated from the rocket body and fell, tumbling in a random manner, to 20,000 ft. where a pilot chute opened to stabilize the fall. At 10,000 ft. the main parachute deployed, and the first space sweeper was lowered safely to the ground for helicopter recovery.

The Yoyo despinner consisted of two steel cables secured to the payload structure 180° apart. A 6.8-lb. weight was attached to the end of each cable and held in place by an explosive bolt after the cables were wrapped circumferentially around the payload.

The nose section also mounted a 16-mm camera for recording the rocket's attitude in flight, a radio beacon for tracking signals, and the Aerojet-designed parachute recovery system.

Working with AFCRL and Northeastern University scientists, the Aerojet Spacecraft Division designed and manufactured the *Aerobee-Hi* rocket, the solid-propellant booster, the special nose cone and the despinner assembly. Their Technical Services Division provided a portion of the launching crew.

The men at Aerojet who are largely responsible for the success of this program are Marvin L. Stary, Division Manager; John J. Beereboom, head of Vehicles Department; Nicholas T. Migdal, Project Engineer; Jack E. Smith, nose section designer; Joseph P. McCabe, electronic systems designer; and Clifford P. Chalfont, Project Engineer for the recovery system. ⌗

Logjam Of Metals Information Broken

GE computer put to work at Western Reserve can read a year's writing in an hour

AN ELECTRONIC librarian capable of plowing through 100,000 encoded digests of technical articles per hour has been put to work to alleviate the information problem in metallurgy.

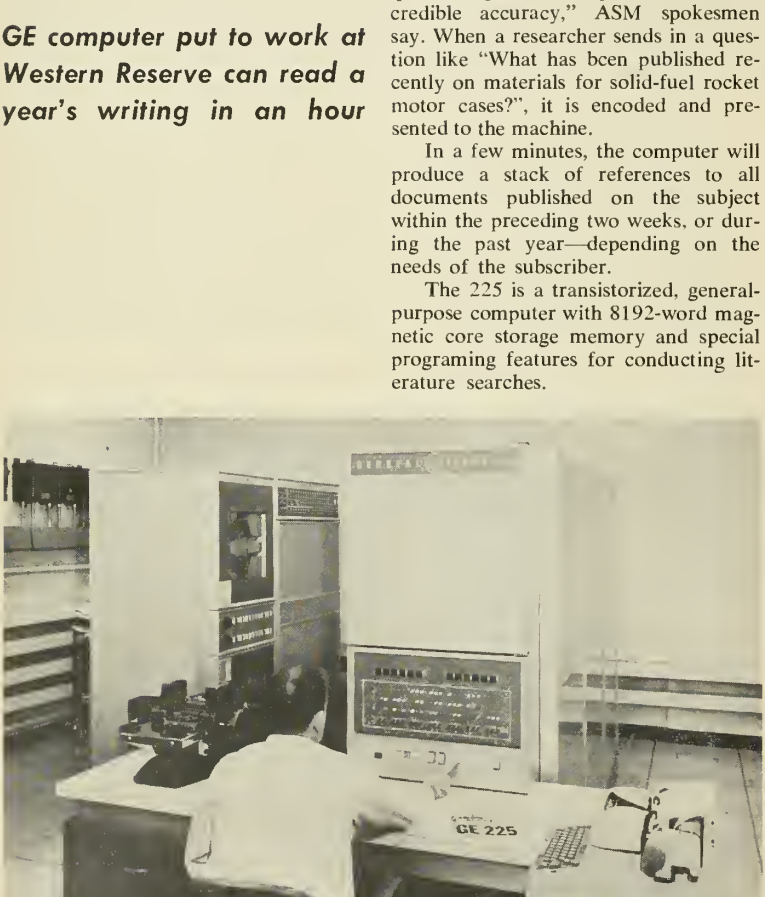
The unit, a General Electric information storage and retrieval system, is the outgrowth of a six-year cooperative program between the American Society for Metals and the School of Library Science, Western Reserve University, Cleveland.

A WRU team headed by J. W. Perry and Allen Kent developed a carefully engineered indexing and analysis system sponsored by ASM funds. The searching selector, as it was called, was studied by GE engineers, and the GE 225 was developed to increase the searching time speed by a factor of 2000.

• **Quiz kid**—The 225 can read an entire year's output of technical literature in a few hours. It can answer any question, general or specific, with "incredible accuracy," ASM spokesmen say. When a researcher sends in a question like "What has been published recently on materials for solid-fuel rocket motor cases?", it is encoded and presented to the machine.

In a few minutes, the computer will produce a stack of references to all documents published on the subject within the preceding two weeks, or during the past year—depending on the needs of the subscriber.

The 225 is a transistorized, general-purpose computer with 8192-word magnetic core storage memory and special programing features for conducting literature searches.



GE 225 CONTROL CONSOLE includes register display, indicator, and status lights. Typewriter produces 10 characters/sec. Card reader (left) scans 400 cards/min.

The unit has a dual magnetic tape handler and controller, a high-speed punched card input, and an electric typewriter output. WRU tape language is compatible with most existing tape installations.

The 225 is located at WRU's Center for Documentation and Communication Research. The Center conducts for ASM a selecting, abstracting and machine searching service covering the articles, books and other materials in metallurgy published throughout the world. Three types of service are available.

—Current awareness searches on a subscription basis: Collections of English-language digests of articles from the world's literature are prepared as the result of machine searches conducted at two-week intervals and are provided according to customer specifications.

—Bibliographic or retrospective searches of literature published over a time span of constantly increasing length. Overnight service is the aim and it is expected that a complete machine library of metallurgical literature covering a ten-year period will soon be available for rapid machine search.

—Encoded tapes will be provided to organizations having their own machine searching facilities on a year-to-year basis. A grant from the National Science Foundation makes possible the processing of patents, government and commercial reports, technical trade publications, and other sources as a supplement to the core program. This includes coverage of the literature of technical fields related to metallurgy—such as physics, mechanical engineering, geology and inorganic chemistry.

• **Operational basis**—ASM spokesmen stress that the information retrieval system is past the experimental pilot program stage and is now a full operational service. It is available to industry today, and can handle all questions on metals and related subjects.

ASM managing director A. R. Putnam challenged U.S. technical societies to solve the vast problem they have created in publishing scientific and technical material. They have a stake in making this enormous amount of material readily accessible.

Although metalworking is the largest industry in the U.S., other technological areas could benefit from the development of a mechanized searching system. Putnam cited medicine, law, chemistry, nuclear physics, electronics and aerospace engineering as prime examples.

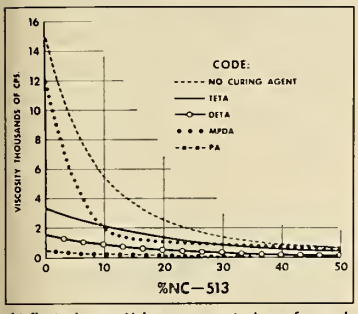
The ARU Center is already embarked on programs in diabetes, disease vector control, electrical engineering and law. The Army's Fort Huachuca center is sponsoring the electrical engineering literature program.



3M MATERIALS MEMO

News of materials for the aerospace industry – selected from the 27,000 products of the 3M Company

Flexibility=More Flexibility



At first glance this appears to be a formula for getting something for nothing. You've no doubt learned through painful experience that such things just aren't so. We're not about to disagree—but we would like to prove the validity of **this** particular expression to you. What we're really saying in our little exercise of semantics is this: the ability to make epoxy resin systems flexible qualifies them for many more and varying applications. Quite logical, isn't it? It's even more so when the desired degree of flexibility is easily controlled and **permanent.**

These and still other properties can become realities for your epoxy systems by using our CHEMICAL DIVISION'S "Cardolite" Brand Flexibilizer NC-513. Even small quantities (less than 10%) result in marked improvement in thermal shock and impact resistance. Its low viscosity offers still further pluses. Your formulated resin flows readily around even complex electrical parts. This reduces to a minimum the danger of air entrapment during potting. This low viscosity means too that you can make greater use of low cost fillers and still have castable systems.

"Cardolite" NC-513 offers you real stability, with no reduction in electrical properties. What's more, all this is permanent since NC-513 actually reacts with the curing agent and isn't merely a thinner. Care to put bend in your blend? Check the box at right.

DINGY DIGITS?

Are you one of the unfortunates with a limited budget who must go on using a computer read-out device, calculator, or typewriter even after the type gets dirty? You have plenty of company. An unpleasant prospect to be sure, but not nearly as bad as the fate of those who must clean the soiled ciphers. As these unsung heroes will tell you, most methods used today are based on the "transfer process." The grime (with **great** difficulty) leaves the digits of the machine and finds its way (with no difficulty) to the digits of the hands.



Our RETAIL TAPE & GIFT WRAP DIVISION has recently developed a product that'll cause type cleaners to throw up their stained and grubby hands with joy. It's simplicity in itself to use—and most important, so clean that the whole job can be done without so much as a smudge on the "pinkies." Called (of all things) "SCOTCH" Brand Typewriter Cleaner No. 575, this unique material is a dry sheet covered with chemically treated flocked fibers which literally grab up the dirt. You need no solvent—no brush—no putty. Just insert the sheet in the carriage and strike the type against it. It's perforated, too, so that as a section is expended, you simply tear it off, and move on to the next. Why not come clean by clipping the coupon below?

GOT A ROVING EYE?

Eyeing the prospect of filament winding a cylindrical or spherical reinforced plastic structure? There's no reason for you to stick (figuratively **and** literally) to the archaic resin pot and dry roving approach. Not when "Scotchply" XP-199 preimpregnated roving material is available to let you do the job quicker, easier and far more uniformly. There's no resin formulation to contend with, no resin/fiber ratios to compute—no mess.



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If you're accustomed to thinking big in R/P fabrication, the wider (¼" to 2") "Scotchply" tapes may be your diet. These come in similarly long yardages and low resin contents. Join the other progressive fabricators who are already familiar with the advantages of "Scotchply" material. Clip the coupon below for more data.

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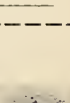
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Armour Study Indicates Maria May B

Bare rock of craters or deep dust of moon's lowlands could be alternatives; volcano slopes, crater floors or mountain-girt plains ruled out by loose dust hazard

by William Beller



ARF'S CONCEPT of a manned lunar spacecraft padded down on one of the moon's many maria.

A NEW STUDY indicates th moon's maria probably have only sha low layers of dust and therefore woul be best for landing a spacecraft.

Alternative landing sites could b either the barren rocks forming th lunar craters, or the possibly deep dus beds of lunar lowlands.

Hard answers to the composition o the moon's surface must await th civilian space agency's *Ranger, Surveyo* and *Prospector* being designed to see out the best sites for the manned *Apollo* Even so, there is a need now to deter mine the best places for these unmanne craft to begin exploring when they ar sent to the moon in the next few years

N. A. Weil, director of mechanic research for Armour Research Institute warns against landing on any slopes o the volcanoes, floors of craters, or o plains ringed by mountains. Landin vehicles—even instrumented ones—ma be "swallowed up" in loose dust.

Retro-rockets, he points out, may b worthless to a craft caught in dust. The would only blow a deeper hole, and th collapsing walls would quickly engu the vehicle.

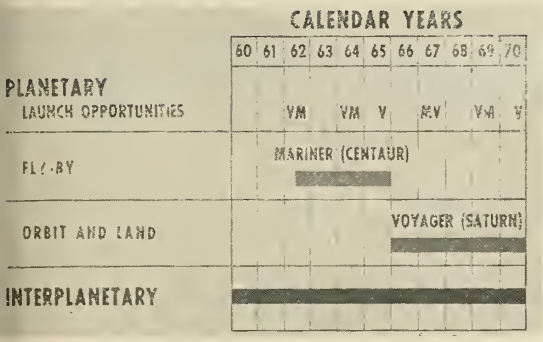
On the other hand, the maria ar believed to be reasonably rigid, smoot and wide open. They also are rel tively easy targets for present guidanc systems.

In a typical maria landing, the v hicle is seen scattering and partially se tling into the thin dust layer coverin the region. Then, for the *Prospecto* series of lunar landing craft, explor tions would be conducted from ba camps established in the maria, b means of large-wheeled automatic lun vehicles.

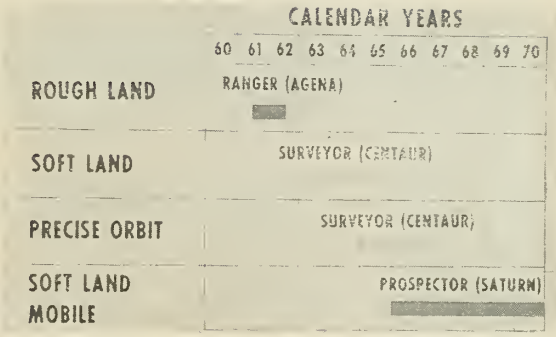
Landing on the exposed rock o lunar craters has the virute of bringi in few unknowns, but the disadvanta of shooting at relatively small targe For this reason, Weil feels that the gui ance problem alone rules out such landing site. He expressed these vie before the First International Confe ence on the Mechanics of Soil-Vehic Systems meeting in Turin, Italy, l week.

• **Current lunar programs**—NAS will first try to rough-land an instr mented *Ranger* capsule on the moo The spacecraft is intended to make te vision and other surface observatio during its final approach. Five fligh

est Bet for Lunar Landings



NASA's planetary and interplanetary program.



NASA's lunar program.

anning one year are scheduled—the st two being test flights—and sched- ed to begin in mid-1961.

What is called the first true lunar soft- nding spacecraft will be developed ıder Project *Surveyor,* which will be ing *Centaur* launch vehicles. Under is project, seven attempts will be made land several hundred pounds of scien- ic equipment on the moon. The first these are scheduled to begin in 1963.

Prospector, which will go aboard *turn* launch vehicles, will be designed land a mobile payload on the moon; one capable of returning sizable ıar samples back to earth. The *Pros- ctor* flights are scheduled to begin in 66.

• **Creeping dust**—On the basis of rmour's studies, Weil said that only e lunar highlands and rims of lunar ıters are free of dust. Here, bare rock apt to be seen, which probably is ing decomposed into dust under ther- ıl defoliation, light erosion, and the pact of meteorites on the hard sur- :e of the exposed rock.

Weil describes the slopes of lunar ıters as being covered by a layer of st, whose thickness may increase to ′eral hundred feet as one descends lower elevations. This dust is said be relatively loose and free-flowing, efly because of the moon's relatively small gravitational field and because of electrostatic forces within the dust particles themselves.

The surface of this dust layer is believed disposed on an inclination somewhat under six degrees, and is slowly migrating downhill under pressure of reflected sunlight, solar proton bombardment and lunar gravitation.

Believing that the dust covering the lunar slopes is in a state of precarious equilibrium, Weil says that any substantial disturbance—such as one created by lunar seismic activity, the impact of large meteors or the landing of instrument packages—might set off a huge lunar "dust avalanche."

The bottoms of lunar craters may be filled with several miles of dust. However, the weight of this dust most probably has a compacting action on the dust in the lower strata, according to Weil.

• **Water source?**—He says that it is also possible that deep layers of lunar dust contain some moisture, originating mostly from impacted meteors, so that at the bottom they may be cemented by moisture frozen into ice.

Weil suggests that the apparent cohesion of the lower strata dust must be quite high, since the friction between the grains would be high when gaseous or liquid lubrication is not present.

For this reason, the bottom layers are likely to be quite hard. Even greater hardness would be met in areas where the heat of impact of colliding planetesimals acting on the lunar surface created localized lava flows.

On the other hand, the dust covering the maria is seen to be far thinner than that in the craters. In convex maria, the dust cover is said to be of the order of centimeters in thickness; while flat or concave maria are seen overlain by dust up to several decimeters thick.

These descriptions of the lunar surface fall in line with observations made through conventional telescope and by radio. On the visible scale, the lunar surface registers rough, since most of the constituent particles of the lunar dust are larger than the wavelength of visible light.

At the same time, lunar gravity acting on the electrostatically excited surface dust would keep the upper layer smooth on the order of wavelength of radio observations—10 centimeters—according to Weil. Any impacting meteor or meteorite would be instantaneously enveloped into the surface dust and sink down into it.

To confirm their findings, Armour research scientists are currently studying the behavior of dust under hard vacuum conditions, dust whose physical characteristics and size distribution closely resemble the anticipated soil conditions on the moon.

Although relatively little is known about the planets, studies are also being made of the probable surface conditions on Mercury, Venus and Mars. ⁂

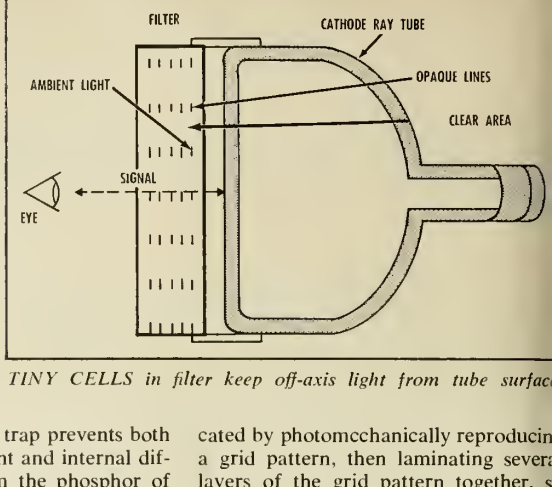
Crater Slopes on the Moon

Crater Dia. (km)	Av. Dia. (km)	No. of Observations	Max. Inner Slope (deg)	Mean Inner Slope (deg)
0-30	12	113	33.5	11.5
30-50	38	14	22.7	9.0
50-100	76	22	14.8	7.2
100+	144	8	11.6	6.0

optics

Trap Keeps Light Off CRT Surfaces

Douglas device, using fine cells to absorb rays, gives unique readability



TINY CELLS in filter keep off-axis light from tube surfac

El Segundo, Calif.—A light trap designed to allow missile equipment operators to read radar, oscilloscope, and other cathode ray tube (CRT) devices, even in bright sunlight, has been developed by Douglas Aircraft Co.

The device, an ambient light-trapping filter, is described as a highly effective "louvered louver."

Vern E. Hamilton, optical design specialist at Douglas' El Segundo Division, said the 1/16-in.-thick trap provides much greater readability of self-luminous signals than do light-trapping prisms, colored filters, projection systems and polarizing screens.

The ambient light trap prevents both external bright sunlight and internal diffused reflections from the phosphor of the CRT from interfering with the operator's observation of the signal.

The trap, designed by Hamilton, is basically a fine cellular structure which prevents off-axis light from striking the CRT surface. The cells are so small as to be unresolvable by the operator's eye.

Absorption of light striking the trap from outside the narrow viewing angle is accomplished by having the cells four to six times as deep as the clear aperture, the aperatures being on-axis with the operator's eye. The trap is fabricated by photomechanically reproducin a grid pattern, then laminating severa layers of the grid pattern together, s that they form the louvered louve design. Each black opaque line in th single lamination then provides an el ment of the cell wall.

• **Problems disposed of**—Hamilto pointed out that a key in the design that the light-absorbing elements are near normal incidence to the ambie light being absorbed, rather than near-grazing incidence as in previou devices. Hence the trap does not gi rise to spurious reflections of the sign coming from the cathode ray tube.

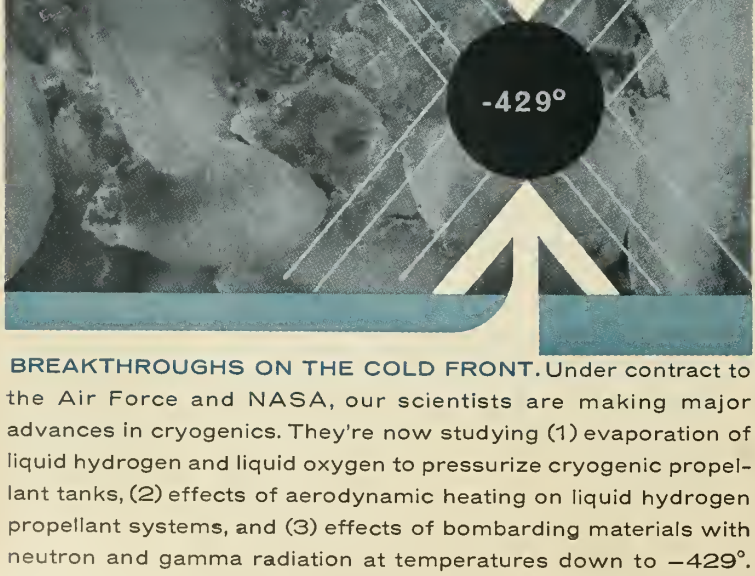
"Another problem we've eliminate with this design," Hamilton commente "is that of reading the white referen lines against the white phosphor of t CRT with high ambient light condition (Lines are usually lit by ambient lig for day use, by edge lighting at night

"The trap is thin enough so that doesn't cause parallax errors when i placed between the scope face and t plate that usually has the reference line The trap creates a black field surroun ing the signal and gives much bett visibility of the white lines."

Principal problem in designing t trap was to find the optimum spaci and dimensions of all elements in t trap system—for maximum eliminati of all unwanted light without interfe ing with the viewer's operations.

Improvements currently bei worked will provide better systems f future equipment, Hamilton sa Among these advances is a transpare phosphor designed to trap light with the CRT; at this time, unfortunate extremely high temperatures are r quired to apply the phosphor to t glass. A special glass must be used, a —since the entire tube can't be made this glass—the design is, so far, i practical.

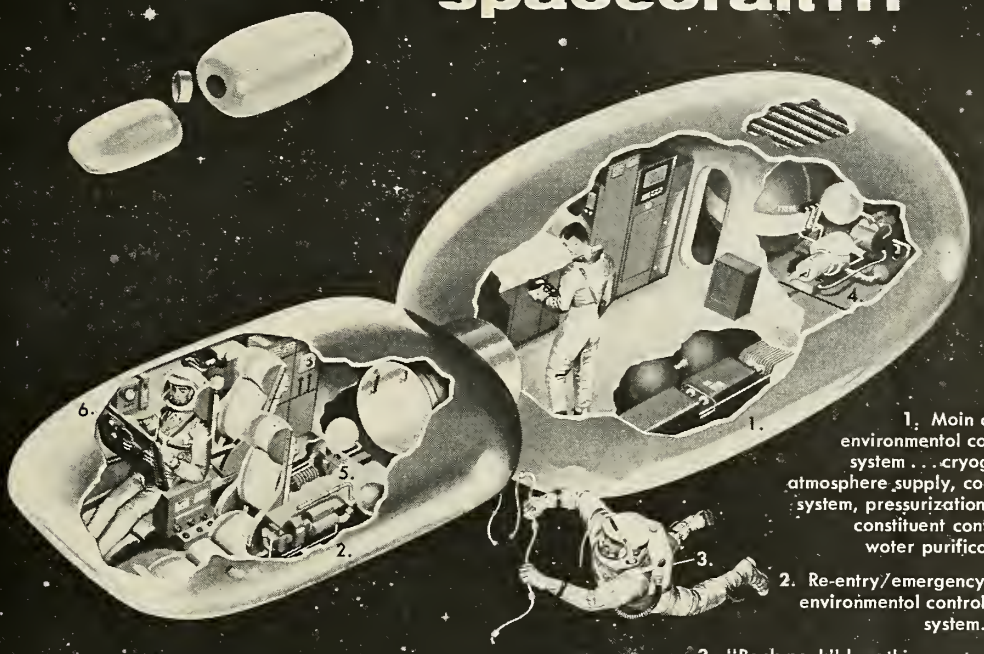
In his own design, he said, he working to get thinner lines, to increa transmission of signals and impro readability.



BREAKTHROUGHS ON THE COLD FRONT. Under contract to the Air Force and NASA, our scientists are making major advances in cryogenics. They're now studying (1) evaporation of liquid hydrogen and liquid oxygen to pressurize cryogenic propellant tanks, (2) effects of aerodynamic heating on liquid hydrogen propellant systems, and (3) effects of bombarding materials with neutron and gamma radiation at temperatures down to −429°.

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Circle No. 7 on Subscriber Service Card

Martin Drives for Top Role in Electronics

Company decides to up separate division as self-supporting entity; in-house R&D expanded

by Charles D. LaFond



EXTENT OF CONVERSION by Martin for electronics production shows in vie of former aircraft tool room being ripped apart. Note old-style wooden-block floor.

BALTIMORE—The mammoth conversion of The Martin Co.'s industrial complex here—now three-fifths complete—dramatically illustrates the company's urgent drive to become a new force in the electronics industry.

Martin's decision to drop out of aircraft production and concentrate on missile and space vehicles as its primary "line" already has been well publicized. Much less attention has been given to a parallel decision to put new and heavy emphasis on expanding electronics—not just as a captive support industry, but as a self-supporting entity.

Some 270,000 sq. ft. of plant area has been allotted to the Electronics Division as part of the 2½-year changeover begun 18 months ago to meet the requirements of Martin's turnabout in technology.

Martin's current annual electronics gross is running at about $50-55 million. Of this, $5 million is from self-generated electronics R&D and production contracts not associated with company missile/space programs. This will increase to from $30-40 million within five years, company officials believe.

To develop this independent role, th company is expanding its self-sponsore R&D in areas where it feels the marke potential is good and no competitor no holds a great lead: ASW and othe underwater engineering; solid-state phy sics and infrared; cryogenics; high-re solution recording and surveillance; an wideband communications.

At the same time, it will try to cap talize on its already developed systen capability to advance in other areas– ground support systems such as trainer simulators, and checkout equipment.

Considerable electronics capabilit was built up throughout Martin's earlie history. Now, many of the departmen involved have been pulled togethe under one roof, and organized as a se arate division under the direction general manager, John J. Slattery.

• **New facilities**—Most striking the new facilities is the manufacturin building, occupying what formerly wa an airplane plant. The factory, sa Slattery, has been painstakingly rebui for maximum layout efficiency, cleanl ness, and appearance. The manufactu ing area includes modern fabrication, a







HREE-INCH CONCRETE flooring is poured over sub-floor tween power duct channels after removal of wooden blocks.



MODERN TILE FLOORING, all-new electrical power ducts are installed. A variety of power types soon will be available.

mbly, and test facilities—with quality ntrol tests in large part built directly to the manufacturing cycle.

A high-grade standards laboratory is aintained for precise calibration of test d laboratory equipment. In several chnical areas, Martin's primary stand-ds equal the level maintained by the . S. Bureau of Standards.

Underwater test facilities are pro-ded on the nearby shore of the Chesa-ake Bay. This is the site of initial outs of prototype listening devices r oceanographic research.

Recent major contracts in the Elec-nics Division include the Air Force's odel 320 Semi-automatic Reconnais-nce System, the Transistorized recon-issance system for technical intelli-nce, the Navy's WV-2 modification ogram, the Electronic Countermeas-es Trainer, and the Fixed Acoustic ioy for undersea sound detection.

• **QRC shop**—For handling quick-action assignments, the division em-oys a unique "short-order shop" anned by a cross-section of some of best technicians. This group can oduce almost any electronic item, in limited quantity, without the need for fruitless paperwork, production engineering or extensive personnel training which so often delay such jobs. Normal inspection and quality control procedures are still maintained, Martin says.

The division also has built its own small plant for producing barium titanate sensors for underwater acoustical studies. Again, because it is built for quick reaction, the plant eliminates the delays usually experienced when new transducer configurations are purchased for test purposes.

• **Advanced studies**—Among its current advanced research projects, the division is developing:

—New infrared materials and cooling techniques. Still classified, the detectors produced so far in this program are believed to be the most sensitive ever built. (These generally are in the far-IR range of 8-13 micron wave lengths, but some are capable of ranges out to 40 microns.) They are also among the smallest—100 microns square.

—Techniques for eventually building "functional" solid-state circuits and sub-systems using thin-film deposition. Most of the current work is fundamental research, but methods have recently been devised for single-crystal growth of silicon at 900°C, said a researcher.

—A fundamental understanding of wideband communications and information theories. Under way for one year, the study is expected to yield useful results by 1963. Current studies are centered on broadband antennas, media effects, coding and high-speed digital techniques.

—Advanced cryogenic techniques. These include new infrared coolers employing neon for field use. Also, Martin-Electronics is developing for the Air Force a special delay line using superconducting metals. The coaxial line is some 15,000 feet in length and only 8 mils in diameter. It has a 2-mil-diameter center core of nyobium, a 2.5-mil-thick Teflon covering, and a 0.5-mil-thick outer coating of lead. The lead will be vapor-deposited. Designed for use in the X-band, the finished unit will be spooled into a final small-can-sized configuration and provide a 20-microsecond delay. ⁂



FAR LEFT: *Final bench configuration. Each station has Magniviewer, soldering equipment, lacing-tie supply, parts bins.*

LEFT: *Conversion is complete. This area, for major console assemblies, has multi-power distribution racks, trolley track for production.*

RIGHT: *Main electronics manufacturing area. Martin says next big step is $4-million in air conditioning.*



Chromatograph Measures Cabin Gases

Beckman Instruments work on designing a compact and lightweight unit for NASA

by Heather M. David

MINOR GASES, harmless in the normal unfettered environment, may pose a serious threat to a space traveler confined in a limited atmosphere.

In the closed area of a space cabin, gases emanating from the bodily processes of the members of the crew or from stored food may suddenly become as toxic as cyanide gas.

The amounts of gases present in the cabin atmosphere must be counted carefully and continually. There are two popular methods of measuring atmospheric constituents: mass spectrometry and gas chromatography.

In mass spectrometry, a sample of the atmosphere is taken and the particles are ionized. The electrified stream is sorted out and identified according to molecular weights.

In gas chromatography, the sample is mixed with a carrier gas and passed through a partition column containing a substance in which the sample materials have different partition coefficients. The unknowns are retained in the column. They are identified by the different periods of time it takes them to travel through the column.

The sample can also be passed through an adsorption column, and identified by differential displacement.

Although gas chromatography is not a new technique, the weight and bulk of existing apparatus make it necessary to develop a radically new and smaller chromatograph for space use.

• **Miniature model**—Now under study at Beckman Instruments, Inc., is an airborne chromatograph for use in future NASA vehicles. Beckman believes it can design an efficient system weighing on the order of 15 lbs., including the electronic sensing systems. Its volume would be less than 1000 cu. in., with total power requirements less than 10 watts, using solar energ and radiation cooling techniques.

One of the ways the company plan to save weight is by mounting the equip ment directly on the capsule witho encasing it. Beckman says separate en casing is unnecessary because the bas components—column, detector and pre sure regulating equipment—are quit rugged.

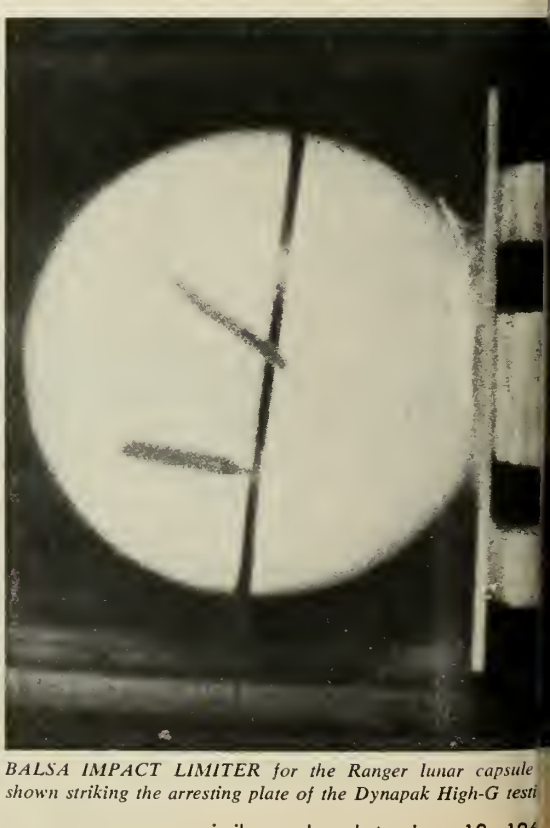
Sampling will not be a problem. Th apparatus can be designed to take a mospheric samples from a number different points successively, or repea edly from the same point. Weight ca be saved by keeping the analysis a simple as possible.

The system can analyze with eas the amounts of oxygen, nitrogen, hydr gen, carbon monoxide and methan present—as well as contaminants suc as CO_2, H_2S, hydrocarbons, organ acids, alcohols, aldehydes and other va pors or condensable gases.

Since oxygen is so vital, the com pany suggests that in conjunction wit



Ranger's Impact Limiter Battered at Ford



BALSA IMPACT LIMITER for the Ranger lunar capsule shown striking the arresting plate of the Dynapak High-G testi

s chromatograph system, the cabin include a polarographic oxygen sensor. This would insure protection of the xygen supply while the chromatograph as being used to determine other constituents. The Beckman polarographic ensor already has been incorporated n the *Mercury* capsule.

A two-column system, possibly utilizng micro-packed columns or capillary olumns, has been proposed by Beckman for spaceship use. The partition olumn would be used for analysis of ondensable vapors or trace elements nd an adsorption column for analysis f fixed gases.

The system could be simplified by aving only a single partition column in hich trace elements are analyzed and xed gases appear as a single component. When an adequate oxygen supply is assured, Beckman points out, this ight be a feasible way to save three or our pounds.

• **Detectors**—Sensitivity attainable y gas chromatography ranges from arts-per-million to the percent level, epending on the kind of detector used.

The company suggests that a thermal conductivity cell would be best for etermining components with higher oncentrations than parts-per-million. his detector has the added advantage f not requiring amplification to operate strip chart recorder.

If small concentrations of some of the trace components are expected, Beckman says, it will consider a low-pressure ionization detector. This has a sensitivity higher by several orders of magnitude than the thermal conductivity cell. It lends itself to use with the extremely low pressures found in space. However, it needs some amplification for indicating or telemetering.

Carrier gases are chosen for the detector used. Beckman says that low-molecular-weight carrier gases are desirable for detectors depending on thermal conductivity or gas density for their operation. For detectors operating on the principle of selective ionization, the noble gases with high excitation and ionization potentials are most desirable.

Direct readout of the system can be accomplished with strip chart recorder, which the company is miniaturizing for space use. Beckman also reports it is looking at meters or recorders which would give visible indication of the levels of components. It probably will include warning devices as well.

Beckman's contract—$20,000 for a four-month project—calls for feasibility studies on a chromatograph for a three-man vehicle. The company estimates it will need an additional 10 months to construct a prototype instrument with testing and evaluation. Phase three—construction of the final instrument, together with the completion of necessary drawings and instruction manuals—would require an additional nine months, the company estimates.

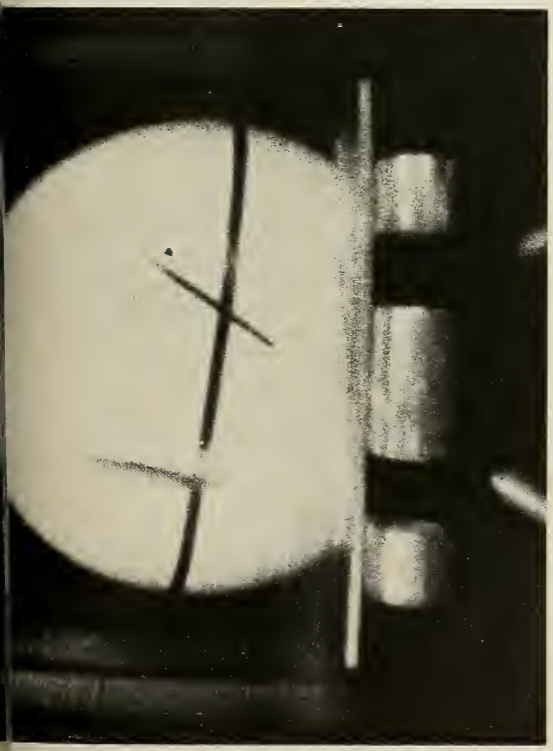
• **Chromatograph vs. spectrometer**—One of the features of gas chromatographs is the ruggedness and simplicity of the basic components, which would be relatively unaffected by accelerations or weightlessness. Solid-state devices would probably be used for amplifiers and control units for reliability.

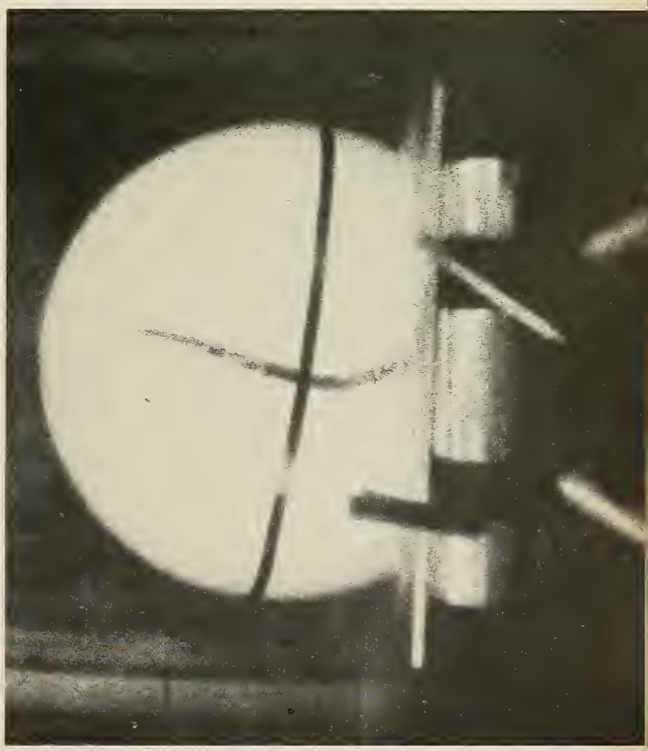
Beckman says gas chromatography offers many advantages over mass spectrometry. The latter system cannot detect carbon monoxide in the presence of carbon dioxide or nitrogen. Since carbon monoxide would be present aboard any spacecraft, careful tabs must be kept on its presence.

A mass spectrometer requires a high vacuum for operation—at least 10^{-5} mm Hg. While this is no problem in space, it may impose difficulties during the final checkout on the ground.

Another disadvantage of spectrometry is the extremely small output (10^{-11} amperes for magnetic mass spectrometers). Beckman says the reason for this poor efficiency is the fact that ions are pulsed down the tube for only a very narrow duty cycle. Therefore, a magnetic multiplier or some other electron multiplying system would have to be used for the detector, creating a considerable hardship considering the rigors of space travel.

The mass spectrometer ionizes sam-





achine at Aeronutronics Div., Ford Motor Co. Hard landings calculated to be as high as 3000 g's. The balsa limiter is machined and constructed to present the largest possible surface area of end grain, allowing random impact.

COMING UP!

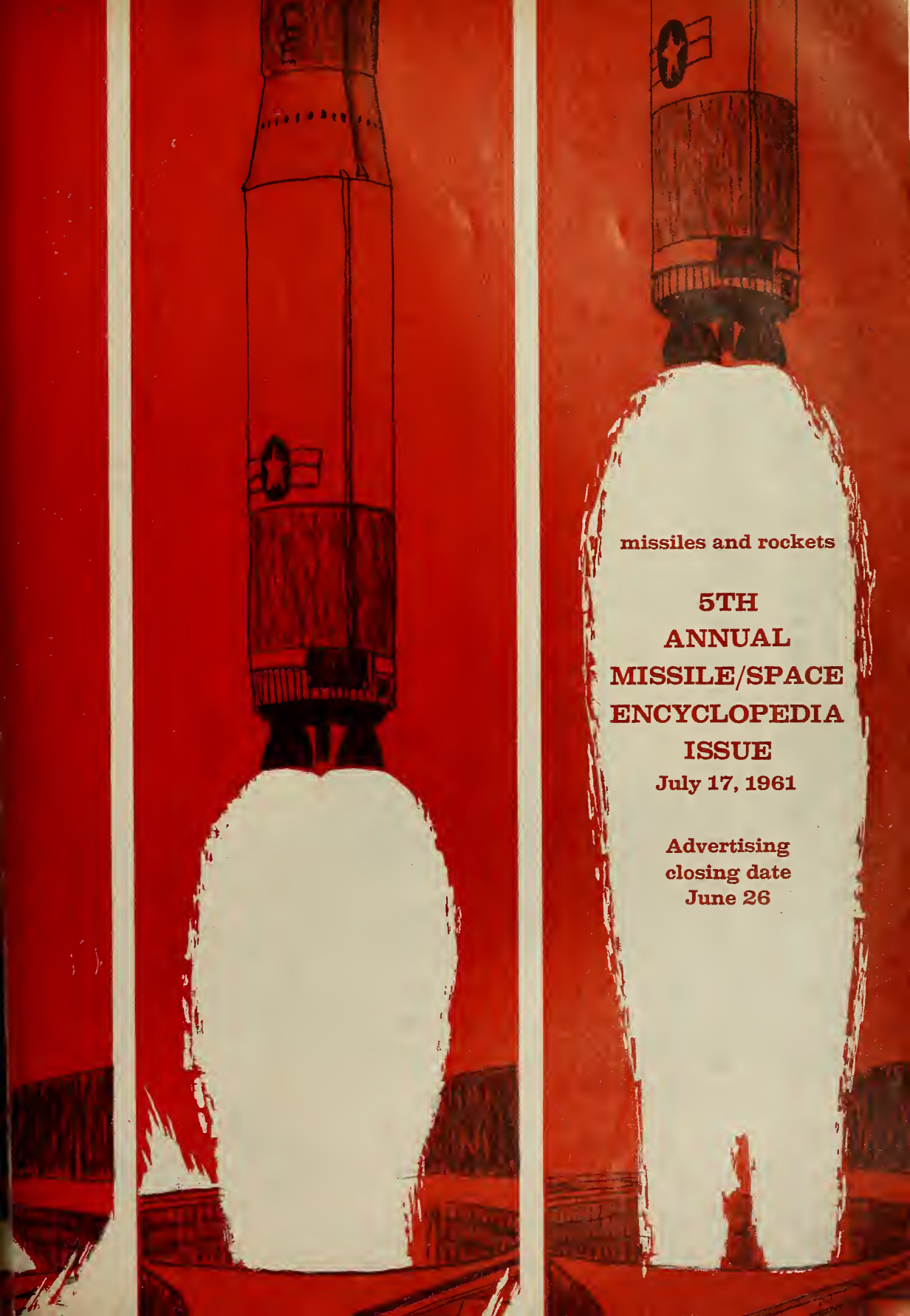
The only single source for a complete and comprehensive analysis of world missile/space systems, M/R's 1961 Missile/Space Encyclopedia will include diagrams and descriptions of all U. S. and foreign missiles and spacecraft.

The 5th annual issue of the Missile/Space Encyclopedia will be distributed to MISSILES AND ROCKETS' 32,500* paid subscribers—plus a bonus circulation of 7,500 for distribution to top military personnel and to U. S. service academies.

With a total distribution of more than 40,000, M/R's July 17 Missile/Space Encyclopedia issue will thus reach virtually all of the people who direct the activities of the missile/space industry, with the most complete coverage-in-depth of key buying and specifying influences.

*Subject to audit.





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July 17, 1961

Advertising closing date June 26

ple gas by bombarding it with electrons, usually from a hot filament. This thermionic emission is deteriorated in the presence of oxygen, creating a stability problem when analyzing atmospheres containing high levels of oxygen. And the fragile filament may be damaged during high accelerations.

When there are more than a few components in the sample gas, the mass spectra becomes very complex. For example, nitrogen causes peaks at mass 28 and 14; oxygen at 32 and 16; carbon dioxide at 44, 28, 16 and 12. Methane, simplest of the paraffin series, produces peaks at 17, 16, 15, 14, 13, and 12. These multiple peaks are due to fractionation of the molecule during bombardment in the ion chamber. If heavier hydrocarbons are present, the number of peaks multiply and a computer must be used for analysis.

Beckman avers that it is hard enough to maintain the constant fractionating patterns necessary for computer analysis in the laboratory; in the changing space environment it would be practically impossible.

Infrared absorption as a means of detecting components has limited usefulness because oxygen and nitrogen do not have absorption in the IR region and cannot be detected. Hydrocarbons, although detectable as total hydrocarbons, cannot be made specific. ⌗

Microorganisms Survive Vacuum

THE HARD VACUUM of space will not automatically sterilize earth-launched vehicles. Recent Army studies show that certain resistant microorganisms survive extended periods of 10^{-9} mm Hg pressures without ill effect.

Staff members of the U.S. Army Chemical Corps Biological Laboratories, Fort Detrick, Md., ran several samples through tests in the ultra-high-vacuum facilities of the National Research Corp.

While the exact degree of pressure prevailing in outer space is not known, it is estimated to be about 10^{-16} mm Hg. The biologists reasoned that if the outer-space vacuum has a deleterious effect on microorganisms, some indication of this would be seen under 10^{-9} mm Hg.

Three microorganisms were chosen —*Basillus subtilis var niger* spores, *Aspergillus fumigatus* spores and *Mycobacterium smegmatis* cells. A five-day exposure was arbitrarily chosen as a time somewhat longer than a one-way lunar mission. The tests were conducted at room temperature in an 85-liter chamber at NRC.

Nine patches, three for each sample, were inserted in the chamber. Each sample consisted of contaminated filter paper patches, dried for 48 hours. For comparison purposes, five other conditions were maintained with the same number and type of patches in each as in the vacuum chamber.

All of the controls were maintained in dessicators, and all except one were at atmospheric pressure. One sample was maintained at 10^{-2} mm Hg. The others were in dry nitrogen, moist nitrogen, dry air and normal air.

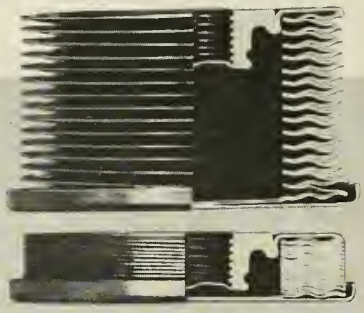
The vacuum chamber reached 5 x 10^{-9} mm Hg six hours after the start of the experiment; by the end of the five-day period, a pressure of 3.6 x 10^{-10} mm Hg was attained.

At the end of the 48-hour drying period just prior to the start of the experiment, three patches were assayed for viable microorganisms to serve as a baseline control.

After the five-day period, the patches were dissolved in distilled water and aliquots from serial decimal dilutions were plated, with a trypticous soy sugar used as the culture medium. The colonies were allowed to incubate.

The results showed that, in general, ultrahigh-vacuum, ordinary lab vacuum and nitrogen atmosphere storage are much more desirable for preservation of viability than the other conditions. ⌗

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Circle No. 12 on Subscriber Service Card

Electrical Propulsion Priority Urged

Los Angeles—The U.S. could test lectrical propulsion devices in space i the immediate future by using bat-eries instead of waiting for nuclear-owered *SNAP* units.

But complacent policymakers are ollowing a "researching to death" pat-ern which could make the Russians rst again.

This is the appraisal of Air Force Capt. Richard Hayes, a liaison officer ith the NASA's Launch Vehicles Pro-rams Office, who believes electrical ropulsion systems should be assigned far higher priority.

Hayes told newsmen at the first ational joint meeting of the Institute f Aerospace Sciences and the Ameri-an Rocket Society that all available cientific literature and other sources idicate the Russians will try to launch small ion engine of the cesium hot-rface type by late 1961. He said ey have programed a higher-thrust uclear-electric space engine for 1964.

NASA won't try to operate an elec-ical engine in space until late 1962. Hayes said a *Scout* will orbit a Hughes sium-fed ion engine and a Lewis ectron-bombarded mercury beam en-gine. And a second *Scout* will put up a 61-beam cesium ion engine developed by Electro-Optical Systems and a Plas-madyne plasmajet thrustor. None of the engines will be tested for propulsion potential. Instead they will be models with outputs of microthrust levels.

In the meeting's two rather extensive sessions on electrical propulsion, the impression was given of considerable dis-agreement as to which system—ion, arc or plasmajet, for example—shows the most promise, should have top priority, has the most "truthful" performance.

Speakers at the electrical propulsion sessions also gave the impression that "their" organization was the only one with a true space simulation system. But they were unanimous in advocating a place in an early payload to prove out concepts and theories.

There was one strong contrast with many other discussions and presenta-tions on the subject of electrical pro-pulsion: members of the audience ap-peared reluctant to publicly contest the speakers' statements and claims. One scientist told M/R: "There's so much yet to be confirmed on neutrali-zation of beams and testing simulators that many of us kept quiet to avoid the hassle that marked the ARS Propulsion meeting in Monterey."

• **Progress**—Some advances in elec-trical propulsion systems were apparent from the papers presented.

Avco disclosed that it has operated its uncooled arcjet engine, reported to be the first of its kind, for several 100-hour continuous runs using hydrogen as a propellant. The company also said it has further simplified the system by using a non-cryogenic ammonia.

Electro-Optical Systems displayed a full-size cutaway of its contact cesium ion engine described as producing 3/1000-pounds of thrust. The engine, said EOS, has operated for 175 hours in a vacuum chamber with no failures. Efficiencies as high as 65% and 5000-to 8000-second specific impulses are claimed.

Hughes Research Laboratories re-ported it had been successful in twin-parallel efforts—ion engine development for flight test plus appropriate support-ing research. The Hughes engine will have a thrust of 1.6 millipounds and a specific impulse of 9000 seconds on a beam current of 58 milliamps. ⁂

CBM Build-up

(Continued from page 13)

r a much larger force, as in the past. me top Air Force officials have talked terms of 2000 or more fixed and obile *Minutemen*. Other Air Force ficials are understood to be talking of out 1000 to 1200.

Soil-boring tests for the possible ing of additional *Minuteman* squad-ns is under way or has been com-eted in six areas. If the present pat-rn of deployment is continued, these eas would accommodate 600 more ed-base *Minutemen* plus half of the 0 which are already planned but for ich no base has been announced.

Meantime, the Air Force is already ving ahead with the doubling of its *inuteman* manufacturing capacity. e scheduled cost: $17 million in FY , $19 million in FY '62.

The Air Force is not establishing a ond source for the missiles at the ime contractor level but plans to seek ond sources among subcontracted rts of the program.

General Gerrity testified that the son the Air Force is not seeking ond sources at higher levels is "the nsfer of know-how to a second source uld be literally impossible without laying this program."

"We find that we can, in effect, accomplish the same purpose by broad-ening the subcontractor base and in many cases bringing in two subcon-tractors to do a specific task when the quantity warrants it instead of one," he said.

The expansion of production capac-ity will involve a $7.5-million expansion in facilities. Most of the expansion money—$4.5—will go into facilities at the Hercules Powder Co. plant in Magna, Utah. The remainder of the facilities money will be spent at the Boeing plant at Ogden, Utah, $700,000; Thiokol plant at Brigham City, Utah, $500,000; and the Autonetics plant at Downey, Calif., $1.8 million.

The essential factor in the produc-tion expansion is that early work must be started on additional *Minuteman* sites by December or earlier if the new capability is to be used most effectively. After December, the value of the in-creased production capability will decline. ⁂

FCC Near Decision

(Continued from page 14)

basis, AT&T automatically would have virtual monopoly control, since it han-dles about 95% of all U.S. international telephone traffic.

• **Legal warning**—Last week, the head of the Justice Department's anti-trust division told Congress that "undue concentration" of economic power has already slowed the U.S. space effort because it "inhibits research and devel-opment." The comment by Lee Loe-vinger was interpreted as an indirect slap at the FCC plan to limit ownership to the carriers.

Loevinger has informed the FCC that to conform with anti-trust laws, it should make sure that all interested suppliers and producers of communica-tions satellite equipment have an oppor-tunity to participate in ownership along with the carriers.

In its revised FY '62 budget, NASA has $50 million earmarked for an in-terim or "transitional" system, which NASA administrator James E. Webb says "will probably be used to accelerate a capability in advance of a commer-cially viable world-wide system."

NASA is concerned that the AT&T system would be designed primarily to handle traffic between the U.S. and Europe. Officials indicate that if the FCC gives the job to the carriers, NASA might use some of the extra money to help the company launch satellites that would extend communi-cations to Africa and Asia. It also might pay for receiving stations on the two continents. ⁂



Pulse Rate Integrator

A compact, miniaturized pulse rate integrator designed for telemetry of missile and airborne frequencies is available from Anadex Instruments, Inc. The Model PI-300-J77 features a self-contained calibrating circuit as well as high input and low output impedances. It has a full-scale output of 5 v and is adjustable over a 4 to 1 frequency range. Input sensitivity is adjustable from 10 mv to 1 v.

The complete unit weighs 20 oz. The unit has printed circuit construction and is potted and ruggedized. Operating temperature is −55° to 165°F.

Circle No. 225 on Subscriber Service Card

Frequency Standard

A low-priced tuning fork oscillator is available from Fork Standards, Inc. The frequency-stabilizing tuning fork is made of a temperature-compensating alloy steel. The silicon transistor drive circuit is self-contained within the plug-in unit. Any frequency for this new oscillator can be furnished between 240 and 2400 cycles per second. Frequency accuracy is said to be ±0.3% from −55° to 125°C and ±0.05% at 25°C. Input voltage for the oscillator is uncritical, and is between 12 and 32 volts dc. Output is 2 volts, RMS minimum into a 5K load or greater, at the minimum supply voltage; output wave form is essentially square.

Circle No. 226 on Subscriber Service Card





Digital Voltmeter

A Series 4000 Digital Voltmeter having full-four-digit measurement displayed on a 3-position tilting readout for greater reading convenience, and automatic ranging and polarity together with ±1 digit accuracy is available from Electro Instructments, Inc. Input impedance is 1000 megohms at balance to ±9,999 volts; 11 megohms to ±999.9 volts. Sensitivity is 0.1 millivolts.

Circle No. 227 on Subscriber Service Card

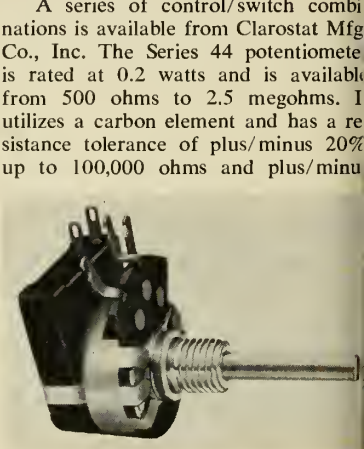
Cheat-Proof Enterlock

Control Switch is producing a multi-station interlocking switch which permits only one station to be committed at any time. Actuating any of the four push buttons causes the previously depressed button to return to normal position. A combination of over-center action button and interlock inclusion prevents the "all station up" configuration. This feature insures that the depressed button's circuit will remain actuated until the system is positively committed to actuation of an alternate circuit or station.

Circle No. 228 on Subscriber Service Card

Miniature Control

A series of control/switch combinations is available from Clarostat Mfg Co., Inc. The Series 44 potentiometer is rated at 0.2 watts and is available from 500 ohms to 2.5 megohms. It utilizes a carbon element and has a resistance tolerance of plus/minus 20% up to 100,000 ohms and plus/minus



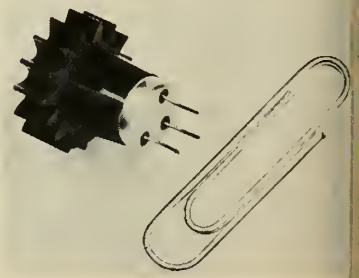
30% above 100,000 ohms. Insulation breakdown between metal mounting surface and element or terminals is over 1000 volts, a-c. Rotation is 300° mechanically with or without switch, 262° with switch.

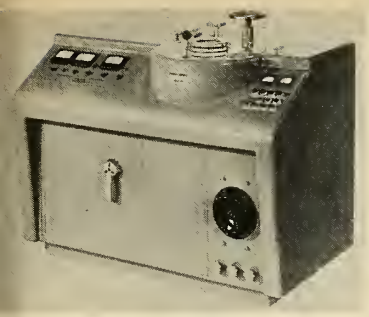
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Transistor Heat Radiator

The Birtcher Corp. has developed a two-combination transistor heat radiator and retainer called "Kool-Tainer." The devices reduce heat up to 25% by virtue of the increased surface area provided in their multi-fin design. Sides of mounting holes are slotted to accept a wide variance of case diameters, from 0.310 to 0.325-in. and 0.475–0.490-in., for all the more important transistor package sizes such as TO-5, -7, -8, -9, -11, -38 and others in the same OD ranges.

Circle No. 230 on Subscriber Service Card





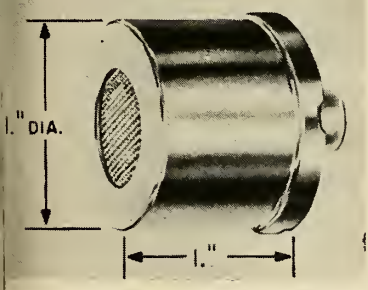
Vacuum Furnaces

A vacuum furnace capable of continuous operation at 2500°C at pressures of 0.1 to 0.05 micron Hg is available from Richard D. Brew Co. A suspension system using floating electrical connections avoids excessive distortion of the heating elements and insures longer life. Heat loss is reduced and less watt density is required. Furnace construction allows an unimpeded flow of gases from the work zone. Furnaces range in size from 54,000 to 27.5 cu. in. due to design flexibility.

Circle No. 231 on Subscriber Service Card

Ultrasonic Transducer

A small, inexpensive precision-transceiving, ultrasonic transducer (40 kc) is available from Massa Division of Cohu Electronics, Inc. As a transmitter, the Model TR-7 delivers sound pressure at about +25 db above 1 microbar at



ft. with 25 mw excitation. The unit's eceiving sensitivity is approximately 2 nillivolts per microbar. With a tuning hoke connected, the 40 kc unit has a andwith of about 4 kc, adequate for oice communication using amplitude nodulation of the ultrasonic carrier.

Circle No. 232 on Subscriber Service Card

ortable a-c/d-c Meters

Portable a-c and d-c ammeters and oltmeters having taut-band suspension, rictionless mechanisms are available rom Westinghouse Electric Corp. The nits have an accuracy rating of 0.5% nd will withstand rough handling, since here are no delicate pivots or jewels to rack and wear.

Circle No. 233 on Subscriber Service Card

Shake-Proof Transducer

A miniature, low-pressure potentiometer transducer having less than 1% error at vibration levels exceeding 35 g's is available from Servonic Instruments, Inc. The Model L-96 is being marketed in 0-10 to 0-350 psi abs. or gage pressure ranges. The unit's liquid-encased design ensures immunity to vibration and supplies permanent lubrication.

Circle No. 234 on Subscriber Service Card

Teflon Slip Ring

Teflon line of slip ring assemblies are available from Electro-Tec Corp. The Teflon clad slip rings are capable of handling very high voltages without characteristic arcing damage even under operating conditions of extreme humidity. At the same time they maintain very high resistance between circuits and offer extreme inertness throughout temperature range of −200°C to +200°C.

Circle No. 235 on Subscriber Service Card

Thermal Reference Junction

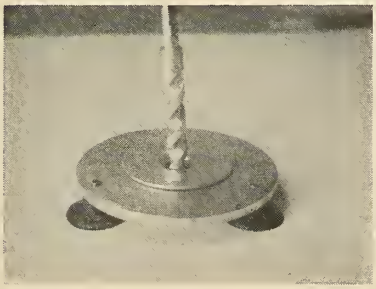
Astra Technical Instruments Corp. is producing a standard line thermocouple reference junction, the RJ-24. A temperature control device, it provides a constant thermocouple reference temperature of 250°F with a 24-channel capacity. Uniformity between junction is 1°F. Ripple is less than ±1°F. Regulation throughout the environmental temperature range is less than 3°F.

Circle No. 236 on Subsciber Service Card

Drill Starter Guide

A drill starter guide which attaches to any surface is available from Morey Products Co. Interchangeable plates come in 11 sizes from 3/16 to 1.5 in. The unit eliminates the need for attachable starter points and is coded GSA Federal Supply Service Item GS-003 -34486. A Model F adjustable precision starter guide for floor and wall holes from 0.5 to 4 in. is also available from the firm.

Circle No. 237 on Subscriber Service Card



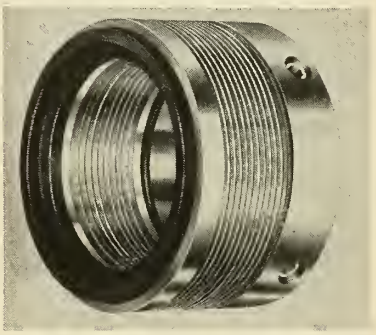
Pressure Transducer

A series of high-temperature gage and differential pressure transducers, the P732, temperature-compensated for continuous operation up to 600°F, are available from Statham Instruments, Inc. Pressure ranges on the gage and uni-directional differential models are from 0-2 psi through 0-5000 psi. The bi-directional differential model operates in ranges from ±1 psi through ±100 psi.

Circle No. 238 on Subscriber Service Card

Rotating Bellows Seal

A rotating bellows seal that will accommodate temperatures from −350° F to 800°F is available from Sealol, Inc. The Sealol 605 is a welded, stainless steel bellows attached to a drive



collar at one end and a carbon retainer for the carbon seal ring at the other end. Sealing of the drive collar to the shaft is accomplished by either a metallic gasket or an O-ring.

Circle No. 239 on Subscriber Service Card

new literature

VACUUM TECHNOLOGY—A catalog on high-vacuum technology and products is available from the Vacuum Products Division, Varian Associates. The catalog contains technical descriptions of VacIon® pumps in sizes ranging from 0.2 liter/sec. to 10,000 liter/sec.; a brief explanation of the pump operating principle; and a list of VacSorb® pumps, power supplies, high-vacuum valves, control units, argon-stable Super VacIon® pumps, basic and special vacuum systems and accessories.

Circle No. 200 on Subscriber Service Card

REINFORCING MATERIALS—Micro-quartz and micro-fibers, two insulating and reinforcing materials for the aviation and missile industries, are described in a 4-page brochure published by Johns-Manville. Micro-quartz is suitable for 2000°F service in steady-state applications, and to much higher temperatures as a reinforcing and ablating component in high-temperature plastics.

Circle No. 201 on Subscirber Service Card

NASA

$877,000—**Grumman Aircraft Engineering Corp.**, Bethpage, N.Y., for design, development, fabrication, test and field support of canister assemblies for inflatable spheres.

$300,000—**General Electric's Flight Propulsion Laboratory**, Evandale, Ohio, for a study of turbines for use with nuclear turbogenerator systems.

$223,060—**Ling-Temco Electronics, Inc.**, Anaheim, Calif., for services and materials for vibration test system.

Kollsman Instrument Corp., Chicago, for development and manufacture of six star trackers for each of the three Orbiting Astronomical Observatory *(OAO)* spacecraft. No amount disclosed.

MISCELLANEOUS

$350,000—**Minnesota Mining and Mfg. Co., Zenith Plastics Div.**, Gardena, Calif., from **The Boeing Co.**, for prototype plastic containers for transporting *Minuteman* missiles.

NAVY

$2,146,999—**Sanders Associates, Inc.**, Nashua, N.H.; $1,200,000—**Sparton Electronics Div. of Sparton Corp.**, Jackson, Mich.—for production engineering and manufacturing of sonobuoys.

$900,000—**Bendix Corp.'s Scintilla Div.**, Sidney, N.Y., for electrical connectors for use in launching tube system of *Polaris* missiles.

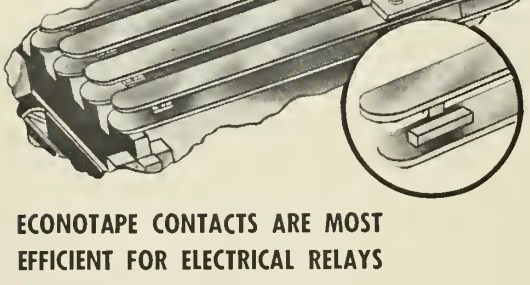
$108,533—**Space Technology Laboratories, Inc.**, Canoga Park, Calif., for design, development, fabrication, assembly and testing of the feasibility model of the PRIMAG Beamformer, study time correlation technique applicable to the AN/BQS-6 sonar system.

General Electric's Ordnance Dept., Pittsfield, Mass., from BuShips, for a shipboard communications tracking antenna system for Project *Advent*. No amount disclosed.

ARMY

$4,646,660—**Waltham Laboratories of Sylvania Electric Products, a subsidiary of GT&E**, Waltham, Mass., for development of an advanced radar design for possible future incorporation into the *Nike-Zeus* antimissile missile system.

$2,408,658—**While Diesel Engine Division of White Motor Co.**, Springfield, Ohio, for 57 engine-generator sets to be used as standby power in the *Titan II* missile program.



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$2,280,000—**Western Electric Co.**, Greensboro, N.C., for continued production of components for the *Nike-Hercules* missile system

$1,600,000—**Norris-Thermador Corp., Norris Div.**, Los Angeles, for Jato units, and components for *Honest John, Bullpup, Sergeant* and *Terrier* missiles.

$1,200,000—**Waltham Laboratories of Sylvania Electric Products, a subsidiary of GT&E**, Waltham, Mass., from Signal R&D Laboratory, Ft. Monmouth, N.J., for ground stations for the *Advent* communications satellite program near Ft. Dix, N.J. and Camp Roberts, Calif.

$562,718—**Raytheon Co.**, Waltham, Mass., for concurrent and replenishment repair parts for the *Hawk* missile system. (Two contracts.)

$250,000—**Greer Hydraulics, Inc.**, Los Angeles, for engineering, manufacture and field service of installations of hydraulic systems at *Titan II* launching sites. (Two contracts.)

$237,221—**Teller Construction Co.**, Idaho Falls, Idaho, for construction of *WS-133A* strategic missile support area facilities, Phase I Munitions Facility, Malstrom AFB, Mont.

AIR FORCE

$1,300,000—**Garrett Corp.'s AiResearch Mfg. Division**, Phoenix, Ariz. for engine starters for the *Hound Dog* missile.

$600,000—**United Aircraft's Hamilton-Standard Division**, Windsor Locks, Conn., for air-conditioning equipment for the B-52H missile bomber.

$514,000—**Stolte Construction Co.**, Los Angeles, for construction of a facility at Vandenberg AFB, Calif., for *Minuteman* missile maintenance and training of *Minuteman* maintenance personnel

$410,000—**Cessna Aircraft Co.**, Wichita, Kan., from **The Boeing Co.** for additional transporter-erector containers for the *Minuteman* missile.

$300,000—**The Martin Co.**, Orlando, Fla., for ARW-73 guidance system for the *GAM-83* weapons system, spare parts and aerospace ground equipment and data.

$275,000—**The Martin Co.**, Denver, for spare parts to support *Titan II* during Operational Capability Force program.

$100,000—**Dunn Engineering Corp.**, Cambridge, Mass., from Holloman Missile Development Center, for a high-precision turntable for testing extremely sensitive gyroscopes in missile inertial guidance systems.

ITT Federal Laboratories, Nutley, N.J., from Aeronautical Systems Div. of AFSC, for development of a "volumetric" three-dimensional display requiring no special stereoscopic eyeglasses to achieve the 3-D effect. No amount disclosed.

ITT Federal Laboratories, Ft. Wayne, Ind., for study of possible designs of automatic, standardized equipment for testing and checking out inertial guidance systems as part of the new Project VATE (versatile automatic test equipment). No amount disclosed

REQUESTS

The National Aeronautics and Space Administration has issued a Request for Proposal for the acquisition, organization, and maintenance of a comprehensive collection of technical and scientific information relating to space and aeronautics activities.

The proposed contract is not a hardware development program; however, the successful contractor will be expected to install an automatic highspeed machine system to meet documentation needs. The contract will be for a period of three years.

Proposals are due to be received at NASA Headquarters Procurement Office, Code BRA, 1520 H St., N.W., Washington 25, D.C., by July 5, 1961.

The evaluation of proposals will be confined to those companies which are principally or entirely concerned with documentation and which have established competence in that field. Excluded from evaluation are companies which engage in development, fabrication, and marketing of aeronautical or space hardware.

The following firms have been invited to participate: Battelle Memorial Institute, 505 King St., Columbus 1, Ohio; CEIR, Inc., 1200 Jefferson Davis Hwy., Arlington, Va.; Documentation, Inc., 25 Connecticut Ave., Washington, D.C.; Nerner and Co., 606 New Hampshire Ave., N.W., Washington 7, D.C.; Institute for Scientific Information, 32 S. 17th St., Philadelphia, Pa.; Johns Hopkins University Applied Physics Laboratory, Baltimore, Md.; Jonker Business Machines, Inc., Gaithersburg, Md.; McGraw-Hill Publishing Co., 330 W 42nd St., New York 36, N.Y.; Stanford Research Institute, Menlo Park, Calif.; Systems Development Corp., 2500 Colorado Ave., Santa Monica, Calif.; United Research, 808 Memorial Dr., Cambridge 39, Mass.; Univ of Pennsylvania, 3815 Walnut St., Philadelphia, Pa.; Western Reserve Univ., Center for Documentation and Scientific Research, Cleveland Ohio; Zator Co., 140½ Mt. Auburn St., Cambridge, Mass.; Armour Research Foundation, 10 W. 35th St., Chicago 16, Ill.

NASA suggests that small business firms or others interested in subcontracting opportunities on this procurement make direct contact with the above firms.

Those firms who can qualify as a prime contractor on this procurement may request a Request for Proposal form from the Contract Negotiator, Mr. R. R. Lane, NASA Headquarters, Attn: BR, 1520 H St., N.W., Washington 25, D.C., Phone DU 2-5630.

GH-STRENGTH STEELS FOR THE MISSILE IN-ISTRY. American Society for Metals, Metals rk (Novelty), Ohio. 276 pp., $12.

The book is comprised of papers pre-nted at the symposium on High-Strength eels for the Missile Industry during the olden Gate Metals Conference, Feb. 4-6, 60, in San Francisco, sponsored by olden Gate Chapter, American Society r Metals. Fourteen authors actively rking with materials for aerospace re-irements are represented.

Contents include "Materials and Fab-ation Problems in Pressure Vessels," tress Corrosion of Aircraft and Missile eels," "Fracture Theory in Pressure Ves-s," "Pressure Vessel Reliability," NASA's Program—High-Strength Sheet loys," "New Ultra-high-strength Steel r High Performance Rocket Motor ases," "Fabrication Techniques for ocket Motors," "Shear Spinning in Fab-ation of Solid-Propellant Rocket Cases," arge Solid-propellant Rocket Case Fab-ation by Deep Drawing" and "Future pplication of High Strength Steels."

More than 200 illustrations, tables, arts and graphs are included.

DESIGN STUDY OF THE INFLATED SPHERE NDING VEHICLE, INCLUDING THE LANDING RFORMANCE AND THE EFFECTS OF DEVIA-ONS FROM DESIGN CONDITIONS, E. Dole rtin. Order NASA Technicol note D-692 from tionol Aeronoutics ond Spoce Administrotion, shington 25, D.C. 82 pp.

The impact motion of the inflated here landing vehicle with a payload ntrally supported from the spherical n by numerous cords has been deter-ned on the assumption of uniform isen-pic gas compression during impact.

The landing capabilities are determined a system containing suspension cords constant cross section. The effects of riations in impact velocity and initial gas mperature from the design conditions studied.

TENNA ENGINEERING HANDBOOK, Henry k, Editor-in-Chief. McGrow Hill Book Com-y, New York. 1040 pp., $22.

The broad fields of antenna engineer-are covered, including such new devel-nents as frequency-independent antennas l surface wave antennas. The book is nded to provide a readily accessible rce of basic information for the an-na design specialist.

The handbook is composed of 35 chap-divided into the broad divisions of ic antenna types, methods, applications, ted engineering and technical informa-n. Each chapter is written by an expert his particular field. The volume in-les among other types, material on long e, slot, loop, helical, horn, reflector scanning antennas. The engineering lications of receiving, transmitting, ar, aircraft, VHF and UHF communi-ons are also covered.

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Dr. Edward P. Sharp: Director emeritus of NASA's Lewis Research Center, has been awarded the NASA medal for "outstanding leadership." Presentation was made by **Dr. Hugh L. Dryden,** deputy administrator, and **Dr. Abe Silverstein,** former associate director of Lewis and now director of space flight programs. Dr. Sharp retired last January after almost 45 years of government service, 39 of which were spent with NACA and NASA.

Lt. Gen. William H. Tunner, USAF (ret.): Former commander of the Military Air Transport Service (MATS), elected to the board of directors of Pioneer Aerodynamic Systems, Inc., Manchester, Conn.

Arthur N. Curtiss: Named manager, administration, RCA Laboratories, with office at David Sarnoff Research Center, Princeton, N.J. Previously Curtiss was general manager of the West Coast Missile and Surface Radar Division, RCA Defense Electronic Products.

Allen J. Gardenhour, Jr.: Appointed northern regional manager, Consolidated Systems Corp., Washington, D.C.

Arthur L. Chapman: Appointed senior vice president of Pacific Mercury Electronics, Sepulveda, Calif. Chapman also will be in charge of marketing and distribution of electronic telemetering equipment for Pacific Mercury's Telemetering Corp. of America subsidiary. Formerly, he was president of the Electronics Div. of Columbia Broadcasting System, Inc. and a vice president and member of the board of directors of the parent corporation.

Col. S. C. Holmes: Named director of industrial operations for the Army Rocket and Guided Missile Agency, Huntsville, Ala. Holmes will be succeeded as assistant chief of staff for research and development by his deputy, **Col. Paul B. Schuppener.**

Arthur S. Lochner: Joins the Curtis Optical Department of Fairchild Camera and Instrument Corp.'s Defense Products Division, Los Angeles, as manager. Earlier, Lochner was division manager at Pacific Optical Corp.

W. F. Wells: Appointed senior vice president and general manager of Midwestern Instruments, Inc., Tulsa, Okla. Previously Wells was manager of manufacturing engineering in General Electric's Computer Dept., Phoenix, Ariz.

Howard T. Cusic: Elected president and chief executive officer, U.S. Polymeric Chemicals, Inc., Stamford, Conn., succeeding **Maarten W. Oudegeest,** elected chairman of the board.

George W. Spencer: Named engineering manager of Erie-Pacific Division of Erie Resistor Corp., Hawthorne, Calif. Prior to joining Erie-Pacific, Spencer was engineering supervisor of a *Minuteman* test and evaluation group at North American Aviation's Autonetics Division, Downey, Calif.

Alfred B. Hunter: Director of customer requirements for Space Electronics Corp., will head the newly-established Washington, D.C. liaison office of SEC.

J. Alan Stewart: Appointed general manager of Sparton Electronics Div. of Sparton Corp., Jackson, Mich. Stewart also is assistant secretary of Sparton Corp., and a director of the Sparton Southwest, Inc. subsidiary.

Louis H. Benzing: Promoted to assistant general manager of the Military Systems/Stavid Division of Lockheed Electronics Co., Plainfield, N.J.

Robert L. Howell: Systems design engineer for Univac Division of Sperry Rand Corp., assigned to Univac's new computer engineering center at Cocoa Beach, Fla.

Adrian C. Bos: Named manager, data processing systems marketing, for RCA's West Coast Missile and Surface Radar Div., Defense Electronic Products, Van Nuys, Calif. Bos formerly was field manager, advanced systems, Federal Systems Division, International Business Machines.

I. E. Boberg: Engineering executive for Chicago Bridge & Iron Co., elected to the firm's board of directors.

Arthur G. Baitz: Appointed assista vice president of Robertshaw-Fulton Co trols Co., Richmond, Va., and gene manager of its Eastern Research Cent King of Prussia, Pa. **William M. Harcu** was appointed director of research a development at the Eastern Research Ce ter.

Raleigh E. Utterback: Named W Coast district manager for closed circ television equipment sales by Gene Electric's Technical Products Operation its newly-established offices in Redwo City, Calif.

Charles H. Crosby: Appointed head *Minuteman* field operations for Aeroj General Corp. at Cape Canaveral, F Crosby replaces **Alfred J. Koorey,** re signed to Aerojet's Solid Rocket Pla Sacramento, Calif.

Dr. T. Grant Maple: Appointed sen physicist in the Research Division of A pex Corp., Redwood City, Calif. Forme Dr. Maple was with the Solid State Ma rials Section at CBS Laboratories, Sta ford, Conn.

Thomas A. Holdiman: Former chief the System Requirements Branch of S tem Development Corp., appointed ch of systems controls in General Dynami Electronics' Military Products Divisi Rochester, N.Y.

Thomas I. Paganelli: Manager of Missile Detection Systems Section of G eral Electric's Heavy Military Electror Dept., appointed head of the departme Systems Operation, recently established consolidate the company's managem skills and technical know-how in surfa based surveillance systems, undersea w fare systems and aerospace defensive s tems.

Maj. Gen. John A. Barclay: Dep commanding general of the Army O nance Missile Command at Redste Arsenal, Huntsville, Ala., is retiring Ju 30 after 30 years of service. Gen. Barc was a pioneer in the Army's long-ra missile developments.

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JUNE

IAS-Symposium on Space Flight and Reentry Trajectories, Paris, June 19-21.

Heat Transfer and Fluid Mechanics Institute Conference, University of Southern California, Los Angeles, June 19-21.

American Association for the Advancement of Science, Pacific Division, Annual Meeting, University of California, Davis Campus, June 19-22.

Sixth International Instrument Show, London, June 19-23.

Denver Research Institute of the University of Denver, Eighth Annual Symposium on Computers and Data Processing, Elkhorn Lodge, Estes Park, Colo., June 22-23.

Institute of Radio Engineers, 5th Annual Convention on Military Electronics, Shoreham Hotel, Washington, D.C., June 26-28.

British Interplanetary Society, European Symposium on Space Technology, Federation of British Industries, London, June 26-28.

Aerospace Transportation Committee, AIEE, Concepts and Design in Aerospace Electricity, Benjamin Franklin Hotel, Philadelphia, June 26-30.

Rocket Testing in Simulated Space and High-Altitude Environments (secret), sponsored by ARO, Inc., Aerospace Corp., USAF, Arnold Center, Tullahoma, Tenn., June 28-29.

American Institute of Chemical Engineers, Second Joint Automatic Control Conference, sponsored with Instrument Society of America, American Society of Mechanical Engineers, Institute of Radio Engineers and American Institute of Electrical Engineers, University of Colorado, Boulder, June 28-30.

Institute of Navigation, Annual Meeting, Williamsburg Inn., Williamsburg, Va., June 28-July 1.

National Bureau of Standards, One-day Meeting on High Precision Connectors, Boulder Laboratories, Colo., June 29.

JULY

Fourth International Conference on Bio-Medical Electronics and Fourteenth Conference on Electronic Techniques in Medicine and Biology, sponsored by AIEE, IAS, ISA, IRE, Waldorf-Astoria Hotel, New York City, July 9-14.

Planning Aspects of Atomic Shelter, seminar, Pennsylvaina State University, State Park, July 9-21.

Western Plant Maintenance and Engineering Show, Pan Pacific Auditorium, Los Angeles, July 18-20.

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editorial . . .

Let's Temper Urgency with Caution

THE UNITED STATES stands a very good chance of being ahead of the Soviet Union in the establishment of a worldwide commercial space communications system. Aside from other benefits, establishment of the satellite network would do a great deal for U.S. technological prestige.

The Administration now has taken the official position that every effort should be made to put the network into operation as soon as possible. To this end, the Federal Communications Commission is engaged in proceedings which could lead to a decision this month as to which commercial group will get a go-ahead on development.

The speed with which the FCC is moving is laudable, and there is no reason a decision cannot be made promptly. But the actions of the commission have raised a question in the minds of some observers as to whether a full and fair study of the situation is under way.

The FCC initiated the proceedings with its frankly stated belief that the space venture should be handed to a group of international common carriers, the largest of which is the American Telephone & Telegraph Co. The commission has, in effect, challenged anyone to prove this position wrong. This "decision in advance" hardly seems a proper approach to an objective study of the case.

The FCC position has been challenged by several missile/space firms—most notably General Electric Co. GE is pushing for a business combine which would include the missile/space as well as the communications industry.

Another challenger of the FCC position has been the Department of Justice, which has raised the anti-trust question in anticipating possible domination of the communications consortium by AT&T. Since involvement in an anti-trust wrangle could delay the start of the program, the Department's position is well worth further study.

A statement presented by the Department suggests that to be consistent with the anti-trust laws, any plan adopted must meet certain conditions. One of these is that all interested parties engaged in the production and sale of communication and related equipment be given an opportunity to participate in ownership of the system together with the common carriers. The Justice statement warns against any set-up which would permit domination by one communications company. It states the belief this could occur despite regulations by the FCC.

The FCC's June 5 hearing, to which interested companies in both the communications and missile/space industries were invited, was held under FCC ground rules which prohibited any challenge to the commission's backing of the communications firms. These challenges are being considered in written form.

Despite the prohibition, the counsel for General Electric managed to raise a number of questions about the proposed communications combine which should be answered before any irrevocable decision is made:

—What formula would be used to distribute ownership among the communications firms or provide for participation in such a way that domination by any one of them would be prevented?

—If ownership is determined on the basis of use, how could it be distributed widely enough to prevent domination by the AT&T?

—What maximums or minimums would be imposed on the amount of ownership?

—What provision would be made for direct public participation in the new venture? Would the public have to go out and buy a share of RCA or AT&T stock to participate?

—What would the timetable be?

—Would there be a separate management group or would it be managed by the dominant company? Would voting rights be on a 90 percent-1 percent-1 percent-1 percent basis?

—If there is to be something other than a separate corporation, how could rates be established effectively with the joint venture reflected as a part of the books of existing carriers?

THERE MAY BE good answers to these questions and to the question raised by the Department of Justice. If so, they should be on the record. GE has outlined its business plans. The communications firms should do the same.

FCC has indicated it will reach a decision before the end of this month—probably in favor of the proposed communications combine.

The need for a decision is urgent. But before it is made, the communications firms should be asked to declare in a public hearing just what their plans for the combine and the satellite network are. The missile/space firms should be given an opportunity at the same hearing to state their case.

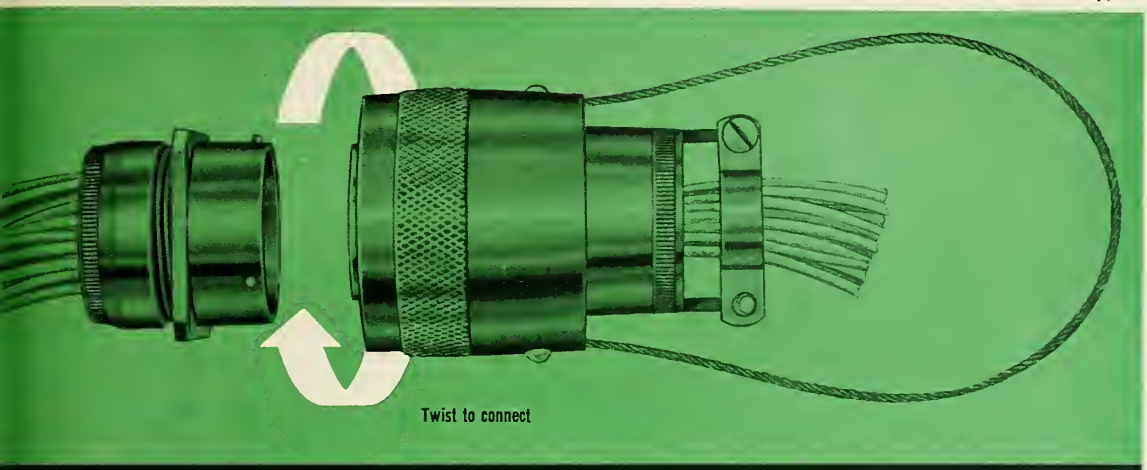
Technical merits of the various satellite systems proposed should be studied.

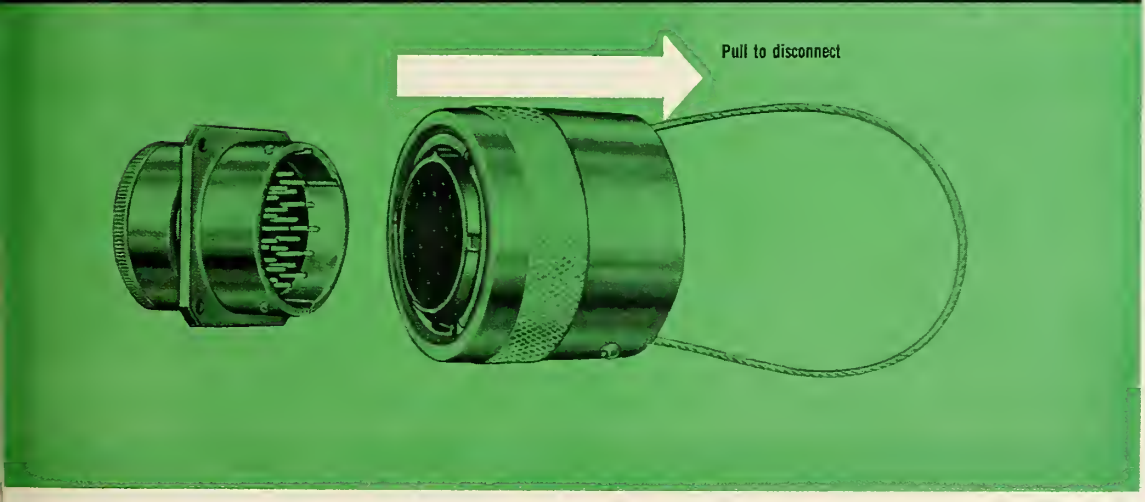
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William J. Coughlin

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deep in research on inorganic polymer structure . . . discovers promising clues to heat-resistant "plastics"

Recent Monsanto research work has uncovered new clues to a theory for predicting inorganic polymer bonds that have high resistance to rupture. Through use of inorganic chemical bonds with indicated polymer-structure capabilities, a number of make-and-see "pilot" polymers have been synthesized and have substantiated the theory. Conventional organic polymers have undergone tremendous commercial development. However, exploration into the new geometry of inorganic molecular structures has put Monsanto on the track of totally new and promising compositions of matter.

Is it possible to develop a "plastic" with rubber-like elasticity that will retain flexibility and a reasonable amount of strength without flowing at the temperature where ordinary glass melts —where iron glows red? What are the odds for discovery of a long-lived coating that would make clear plastic windows "scratchproof" . . . or a protective "heat-shield" wire coating that would permit electric motors to run efficiently up to 400°C.? These products and many more may well be found in inorganic polymers of carefully planned molecules.

Now, Monsanto chemists are exploring ways to catalog basic parameters that predict inorganic molecular structure. From application of this basic knowledge, inorganic chain structures may be tailored specifically to zero-in on promising inherent properties such as rigidity, elasticity, strength, stability and high resistance to heat. In general, organic polymers are limited to around 250°C., but more heat-stable inorganics might extend the polymer endurance range to 500°C. or beyond!

A NEW WORLD OF POSSIBILITIES

Actually, hundreds of inorganic polymers are already known, but few have the properties needed for space-age engineering applications. On the other hand, via atomic architecture, literally thousands of inorganic polymers are possible. Only a relatively small proportion of these have as yet been synthesized and examined.

To help predict the properties of inorganic polymers, Monsanto chemists have devised some new methods and adapted many recently developed techniques for characterizing chain structures. Applying elution fractionation to crystalline and amorphous polymers, they developed a new reliable procedure to establish molecular-weight distribution. To uncover other clues to inorganic polymer structure they have employed selective hydrolysis, solution chromatography, differential thermal analysis, and such techniques as nuclear magnetic resonance. Out of all this work on the riddle of molecular configuration have come some leads that may point the way to the "500°C. plastic."

At first inspection, the multiple deficiencies of existing materials are discouraging. But major goals are abundantly clear: chemically, the ideal inorganic polymer must not react with its environment; it must not decompose under heat and mechanical stress; it must resist molecular reorganization. Apparently, from the relatively slow progress that has been made toward these goals, something radically new and different is needed—totally new mechanisms rather than research modeled after organic polymer mechanisms.

IMAGINATION MAPS A RESEARCH ROUTE

A key to Monsanto's research approach is in *controlling* the structural reorganization of inorganic molecules. This chemical phenomenon has been well known in special cases, but its general importance to inorganic chemistry has only been recognized in recent Monsanto studies. Control of molecular reorganization may be the answer to designing useful, heat-stable inorganic polymers.

In order to create an inorganic material with elasticity, it is necessary to have straight-chain, only-occasionally-branched molecules able to assume various configurations . . . so the energy of deformation can be stored by reducing the configurational freedom. The elastic stretch comes from straightening molecules throughout the body of material. If molecular chains undergo simultaneous making and breaking with interchange of parts, there is no permanent elasticity, but rather, the properties of a viscous fluid.

In recent exploratory studies, molecules tailored for the purpose of controlling molecular reorganization have given clues both to patterns of stereospecific regulation and to "building blocks" that show promise. For example: "pilot" compounds of high molecular weight have been prepared based on phosphorus. The physical properties have been controlled to the point of turning out compositions in the form of elastomers or as rigid solids!

(Please turn page)

The rigidity is derived either by built-in cross-linking or by "sprinkling" ionic charges along the polymer chain.

Although the pilot compounds in themselves are not satisfactory, these polymers (and others) have revealed sufficient clues to prompt Monsanto research into a frontal attack on the problem of finding high-heat-resistant inorganic polymers in the jungle of chemical compounds that contain no carbon-to-carbon linkage.

INORGANIC CHEMICALS FOR CREATIVE SYNTHESES

Several novel combinations of selected elements offer promise of high stability—and Monsanto research has started examining the more promising ones. The search is two-fold: first, synthesis of the predicted polymer and study of its properties; next, "creation of clean reactions" to make it.

A variety of structures is under study, among them . . . compounds having phosphorus-to-phosphorus and phosphorus-to-carbon bonds . . . cyanofluorocarbons, isocyanate and ketene analogs with bonds between boron, carbon, sulfur and nitrogen . . . conjugated fluorocarbons . . . polymers containing the –C=N–C=N– skeleton . . . polymers from metal-phosphorus linkages, and others.

HIGH-TEMPERATURE POLYMER RESEARCH . . . a chemical capability of Monsanto

Over a dozen Monsanto research projects are aimed at the development of heat-resistant materials for structural use, for imbedment of electronic parts, for coating purposes, and for high-temperature fluids. Hopefully, even high-temperature elastomers may be developed for such uses as O-rings, diaphragms and gaskets.

If you are working on a problem requiring a heat-stable compound for special service, you are invited to discuss your needs with Monsanto. Write or call: Monsanto Chemical Company, Department MR-6, C Building, St. Louis 66, Missouri.



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missiles and rockets

Volume 8, Number 26 June 26, 1961

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THE COVER

Fairchild Stratos Corp.'s highly regarded SD-5 Army reconnaissance drone is company's biggest contract winner and major factor in plans for the future. See p. 30.

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† U.S. Reg. Pdg.

35,630 copies this issue

letters

Space Drive Rebuttal

To the Editor:

An article in M/R, June 12 (p. 24) is entitled "Consultant's Report Overrides Dean Space Drive," and refers to an Air Force contractor's report.

The Drive is neither overridden nor buried. We have been concentrating here and in other countries on the strictly commercial and immediately realizable applications of the Drive. Space is not our business, but to make our position clear, please be informed that realizable projections of the Drive would take one man, or one hundred men, to the moon and bring them back as readily as the Queen Mary crosses the Atlantic. The only question is—what country does it first.

Analysis of the Air Force Rabinow adverse report shows that every reported test, except the first general set-up, was made under relationships or operating circumstances that are guaranteed to produce no positive result, and which are so stated in information that I gave to both the Air Force and its contractor, and which they had in their possession.

Questions of why these selected relationships were reported to and accepted by the Air Force as being an analysis of my loaned equipment should be directed to the Air Force. If the Air Force wishes to know of other ways in which this equipment will not produce positive results, I will supply them without the expense of a contractor. I believe, however, that the Air Force should be more interested in how unidirectional thrust is created than in how it is not. The Rabinow report appears to be dedicated to the latter proposition.

A detailed analysis of the fundamental errors in the report is in preparation. A copy will be sent to you.

Let me be clear. We are not engaged in a contest. There is no contest. We are going to have to live with the Drive whether we want to or not, for its success no longer depends upon any one person, group, agency or country. What we can do here is to demonstrate the responsibility required, I believe, by all of us....

Norman L. Dean
Washington, D.C.

The balance of Mr. Dean's letter concerned the background of his work on the Drive and how he supplied information and test equipment to the Air Force.—Ed.

To the Editor:

I was rather shocked with the space that M/R gave the Dean gravity Whirligig (M/R, May 1, p. 24). It was gratifying, therefore, to see the contraption unhinged by Rabinow in the June 12 issue.

I would, however, like to put a final nail in its coffin.

In the May 1 article mention was made of the non-simultaneity of action and reaction. It is true of course that nothing occurs at infinite speed. The gravitic action of object "A" upon object "B" must incorporate a transport function. Similarly, the gravitic action of object "B" upon object "A" (and this is non-identical with the previous action) must also include a transport function. As a result gravitic actions and neither really mutual nor simultaneous.

Newton's laws are therefore exactly applicable only under special, tranquil conditions.

Fortunately, when we apply these considerations to a machine of the dimensions of the Dean machine, we find that any effects are completely swamped by such things as ordinary thermal agitation. As a result, if the machine were warm enough to run its gravitic effects could never be measured.

I was particularly interested in the Dean-Rabinow results since I built a machine along the same principles when I was an 8-year-old schoolboy. It worked real good as I remember and was powered by a Lionel train transformer. The only trouble was I could never get the thing to rise off the table.

Robert E. Span
Registered Engineer
Rector, Pa.

Tiros' Other Eye

To the Editor:

I note in M/R, May 29, p. 18 a paragraph concerning *Tiros II* having been in orbit for six months and still transmitting. I would like to call your attention to the fact that both television cameras are still operating. . . . A high percentage of pictures from both cameras are being used for meteorological purposes.

M. G. Staton, Manager
Market Development
Astro-Electronics Div.
Defense Electronics Products
Radio Corp. of America
Princeton, N.J.

M/R reported that Tiros II's narrow-angle camera was operating perfectly, failed to mention the wide-angle camera —Ed.

Yes, Anti-ASW

To the Editor:

In reference to your COUNTDOWN feature in M/R, June 12, p. 9 (reporting that "the FY '62 budget contains $8.3 million for anti-ASW R&D work in the field of ship noise reduction"), I would like to remind you that ASW stands for anti-submarine warfare, and that, therefore, anti-ASW warfare would mean submarine warfare.

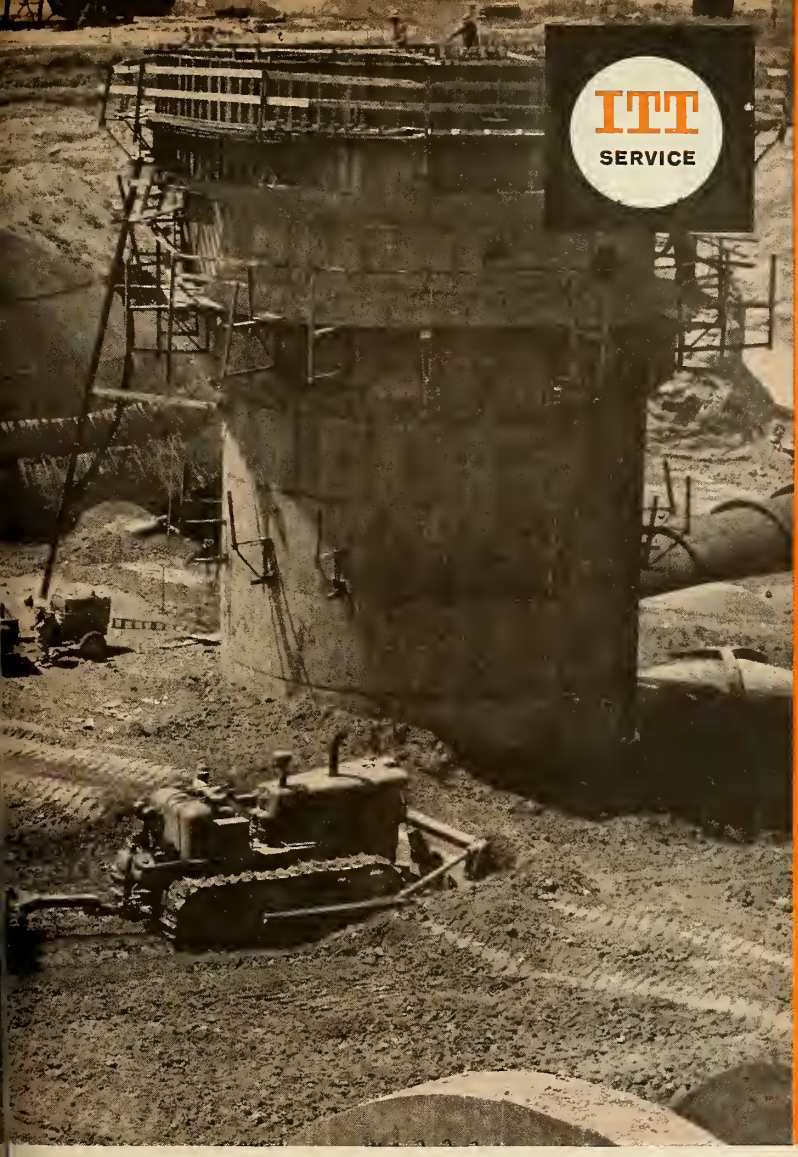
In our book, ship noise reduction would be classified as anti-submarine warfare.

N. A. Denman
General Manager
Basic & Experimental Physics
Falmouth, Mass.

As a matter of fact, the ships involved in the program in question are submarines. Hence, the work is properly categorized as anti-ASW (or, if you prefer, submarine warfare) R&D.—Ed.



Federal Electric Corporation Preside
J. W. Guilfoyle (on left), inspects typi
underground passageway during ini
phase of the complex's activation by F



reporting from TITAN base T-4 ...to military system managers



. . . operational readiness of the TITAN system has been assured by Martin Company's comprehensive planning for electronic technical support.

. . . the hard base TITAN complex at Larson AFB, Moses Lake, Washington, is now being activated by Federal Electric Corporation, Service Associate of International Telephone and Telegraph Corporation.

. . . TITAN prime contractor, the Martin Company, is calling on FEC for:

- Installation and test of Martin furnished TITAN ICBM's and ground equipment
- Interim operation
- Support services for other contractors on the site
- Assistance to Martin in turning the complex over to the Air Force

. . . this company was chosen to activate TITAN Base T-4 because:

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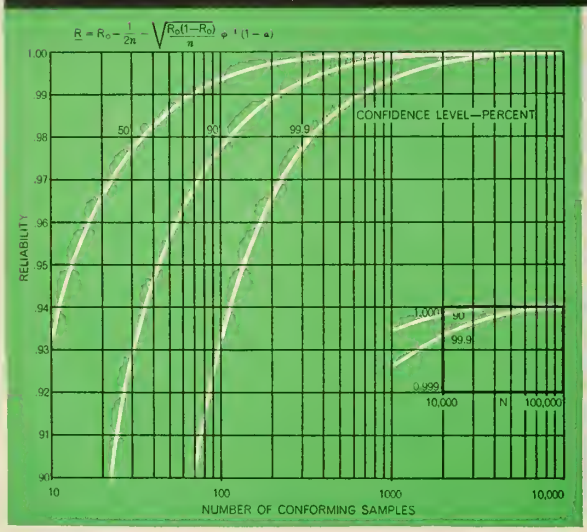
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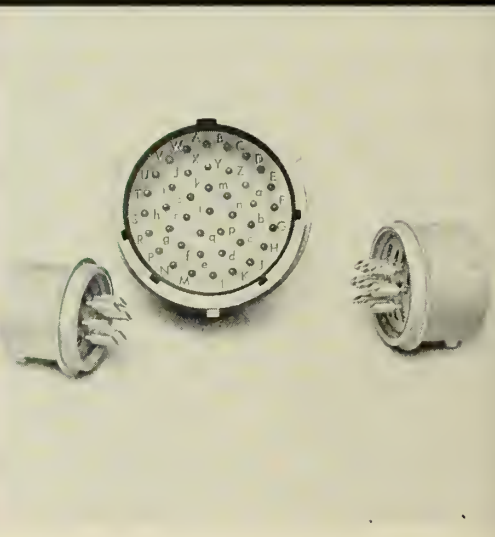
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The Countdown

WASHINGTON

Blue Water for Sergeant?

COUNTDOWN hears the U.S. Army top command is studying a field command recommendation to buy the English Electric *Blue Water,* instead of stocking Sperry's *Sergeant.* Argument from the men who have to shoot 'em: *Blue Water* will have a shorter countdown, less GSE and fewer "black boxes" to contend with. There is also the feeling that *Blue Water* (due to become operational in 1963) is more mobile and is generally a more advanced weapon—because of its eight-year development cycle—than the *Sergeant,* which is already operational in limited numbers.

How McNamara 'Leans'

Defense Secretary McNamara is sticking to his decision not to go beyond a 29-boat *Polaris* program; neither is he giving any indication of buying more than 600 *Minutemen* for the present. In newly released testimony before the Mahon Committee earlier this month, McNamara says it costs about $1 billion to: 1) buy 40 B-58's and operate them with tankers for five years; or 2) buy 45 B-52's with tankers and operate them for five years; or 3) buy 150 *Minutemen* in silos and maintain them for five years; or 4) buy 6 *Polaris* subs and operate them for five years. Ruling out B-58's because of their short range, McNamara says that if he did ask for another billion, "I would lean today toward either *Polaris* or *Minuteman.*"

New Minuteman Sites Picked

Bases for 150 *Minutemen* each will be located at Whitman, Mo., and Minot, N.D. The sites for the six (50-missile) squadrons will round out the currently-planned force of 600 *Minutemen.* There are 150 going in at Malmstrom AFB, Mont., and another 150 at Ellsworth, S.D.

More AF Range Ships

Air Force is in the process of angling for three more mothballed Navy vessels which it intends to convert to range ships. Cost per conversion: $20 million.

Blimps' Demise

Unless Congress reverses the Administration, the Navy's dwindling ASW blimp force will die altogether as of June 30. Cut from 22 in FY '57 to a current total of 8, the blimp force will fade from existence for want of an appropriation amounting to only $5 million.

Marines Evaluating Entac

Already on order by the Army, Nord Aviation *Entacs* are being evaluated by the Marines. Some U.S. military men are now contending that *Entac* is the simplest antitank missile yet to appear on the market.

Ranger Launch Slipping?

There's word from Canaveral that the first launch of a *Ranger* lunar vehicle scheduled late next month may be delayed, although Lockheed is presently completing compatibility tests of the first proof-test model of the spacecraft with an *Agena B.* First and second shots of the *Ranger Agena (RA-1, RA-2)* will be to run engineering checks and to "road test" cislunar space. Not until *RA-3* will a lunar hard-landing be attempted.

INDUSTRY

Bambi—No Future?

While development is continuing as part of the *Defender* program, DOD R&E Chief John Rubel concedes that the *Bambi* satellite approach to knocking down ICBM's in the boost phase doesn't look very promising. Rubel says 25% of the *Defender* effort is now going into development of high-powered radar and other sensing devices.

R&D Intelligence

First flight rating tests of the Rocketdyne F-1 engine are now targeted for March, 1963. . . . Reynolds Metals estimates 35 million lbs. of fine aluminum powder will be burned annually by 1965 in solid-rocket firings. . . . A solid-fueled rocket fired last week by United Technology Corp., says the company, racked up highest overall performance ever recorded. Contributing factors: a lightweight glass casing, extremely thin insulation, uprated propellant and advanced nozzle design. . . . Air Force on June 21 fired the last shot in the *Mace B* development program. Launch crews from 4504th Tactical Missile Wing will begin training with the bird this summer.

Uneasy Bedmates

No arrangements have been made yet to coordinate Air Force and NASA solid rocket development (see p. 14). NASA is hoping it will have some say in how the Air Force spends the money—some $2 billion over the next three years. But it may get none at all. Question revolves around whether NASA will get responsibility for stage construction and integration—or whether the Air Force will take over the whole job, including motor development.

INTERNATIONAL

ONERA Builds Wind Tunnels

Two hypersonic wind tunnels—one Mach 7 and the other Mach 20—are now in operation by ONERA, the French counterpart to NASA. The tunnels are being used for re-entry vehicle design.

Overseas Pipeline

The British War Department's Proof and Experimental Establishment at Pendine, Wales, is now studying re-entry problems on a rocket-propelled sled. . . . More high-altitude tests with *Véronique* rockets are underway over Colomb-Béchar in North Africa. . . . Russia's Yuri Gagarin now says in a book he has written that during re-entry from his globe-girdling flight, his *Vostok* was enveloped in flame. "Its outer skin became hot rapidly," he says, "and through the blinds covering the portholes I saw the ominous purple reflections of the flame racing around the ship."



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The Missile/Space Week

Typhon R&D Award to Bendix

Bendix Corp. has been chosen as R&D contractor for the Navy's solid-propelled *Typhon* missile system.

The system, which will have both antiaircraft and antimissile capability, will include shipboard control units, radar, launching systems and missiles.

General Dynamics/Pomona, subcontractor to Bendix, will develop parts of the guidance system. Johns Hopkins Applied Physics Laboratory conducted preliminary design work and will have technical direction over the R&D program.

Shot of the Week

A 150-ft. dipole antenna—the largest ever put in space—has been successfully tested at altitude. Fired up to 560 miles with a four-stage *Javelin* rocket, the two 75-ft. arms of the antenna were extended to length by radio command from NASA's Wallops Island launch facility.

The antenna is so fragile and light —each arm weighs only seven pounds —that the extension procedure had to be tested outside the gravitational effects of the earth.

Although the experiment was reportedly less than 100% successful, project scientists were satisfied that the antenna had proved feasible.

The unique antenna is to be used in Canada's *S-27 Topside Sounder* satellite scheduled for launch early next year. The joint U.S.-Canadian experiment will probe the ionosphere from above, using a swept-frequency technique to explore propagation characteristics. (See related story, p. 12.) After the *S-27* satellite goes into orbit, it will be known as the *Alouette*.

The new technique used to store the antennas during boost and extend them in space was developed jointly by de Havilland Aircraft of Canada and the Canadian Defense Research Telecommunications Establishment.

Before extension, the antennas are stored as a thin (0.004-in.) steel strip rolled on a drum, similar to a coiled steel-tape rule. On command, a small electric motor unrolls the strip through a fiberglass guide sleeve which forms the strip into a tubular shape.



JAVELIN payload with record anten

Before extension, the payloa carrying the antennas was programe to be spun up to 650 rpm. Aft extension, the spin rate was to l decreased to 135 rpm. This pr cedure was used to test the antenna ability to withstand the spin forces will meet in the operational spi stabilized satellite.

The 62-lb. *Javelin* paylo reached a velocity of 9200 mph on 18½-min. flight. It landed in t Atlantic some 750 miles down-ran from the Wallops launch site. Reco ery was not planned or attempte

Discoverer Netted

Discoverer XXV, launched Ju 16 from Vandenberg AFB, Calif., l came fifth in the series to be rec ered after orbit in space.

The 300-lb. capsule carried spe mens of rare metals, radiation a micrometeorite counters.

Skindivers recovered the paylo from the Pacific north of the recov "ballpark" where Air Force C-1 planes were waiting to snag the c sule as it fell. The capsule ejected command on its 33rd pass, a spending 50 hours in space, but slightly afield of the designated a

The *Thor* booster stage of the hicle was guided by radio comma instead of the autopilot used by pr

ous *Discoverers*. Satellite stage was he *Agena B*.

Air Force scientists are studying netals carried in the probe, which in-luded gold, bismuth, iron, cadmium, nagnesium, nickel and yttrium.

The Air Force had hoped to leave he satellite in orbit four days but erminated the mission because of redicted bad weather conditions in he recovery zone and technical con-lition of the satellite.

Advice on Advisers

The streamlining of scientific and echnical committees now advising he President is urged in a Congres-ional staff study just released.

The study declares that an Office f Science and Technology should be et up within the Executive Office of he President. It would have two jobs: Make recommendations to the Presi-lent for meeting long-term national eeds in science, and help the Presi-ent coordinate and evaluate agency rograms by serving as technical ounselors to him and to the Bureau f the Budget.

Head of the new Office would be ne Special Assistant to the Presi-ent (now Dr. Jerome K. Weisner).

It would also include the Federal 'ouncil for Science and Technology, ne President's Science Advisory 'ommittee, and an expanded special :aff.

The study criticized the present :tup, saying that the President's :ience advisers "had not yet done nough in helping the President and ne Bureau of the Budget coordinate nd monitor major government tech-ical programs."

lew Nuclear Manager

NASA has established a nuclear :hicle projects office at Marshall pace Flight Center to oversee de-lopment of nuclear rocket stages for *turn* and follow-on space systems. hief of the new office is Col. Scott ellows, USAF, under assignment to ASA. Deputy is William A. Brooks-ank, Jr.

First project for the new office is manage development of the *RIFT* hicle, slated for *Saturn C-3* second-age tests in 1966-7. *RIFT* will use e NERVA engine, now under de-lopment by Aerojet General and estinghouse.

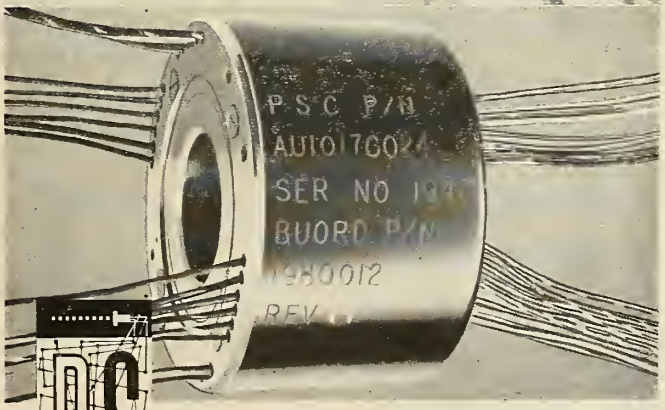
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Probing past F2 . . .

S-48 to Sound High Ionosphere

Fixed-frequency satellite will measure density of electrons; Canada's S-27 to use swept frequency

A MAJOR ASSAULT on the upper ionosphere will begin next year with the launching of America's *S-48* satellite—one-half of an international project to measure electron density above the F2 layer.

The project is aimed at collecting data important to high frequency communications and manned spaceflight.

The fixed-frequency *Topside Sounder* is being developed for the National Aeronautics and Space Administration by the Central Radio Propagation Laboratory of the National Bureau of Standards (NBS-DRPL) and by Airborne Instruments Laboratory, a division of Cutler-Hammer, Inc.

In a complementary project, Canada is developing a somewhat different ionosounder satellite which will be placed in orbit in early 1962, shortly before *S-48* is launched. Known as *S-27*, swept-frequency *Topside Sounder*, the satellite will round out the total *Topside Sounder* program.

NASA was to launch an *Argo D-4* rocket probe from Wallops Island, Va., last week in the first flight test of equipment being developed for eventual use in *S-48*.

The U. S., Canada and the United Kingdom will collect data independently from both *S-27* and *S-48* at ground stations around the world. Recorded data will be exchanged.

• **Nature's radio mirror**—The reflective and refractive characteristics of the ionosphere have been used for many years to increase radio transmission range. In recent years, by employing the scattering effect of the ionosphere, VHF point-to-point telecommunications have been used extensively by the military services. Ionospheric-scatter communications offer unusually high reliability and secure circuits, not intolerably degraded by sun-spot activities.

Yet little is known about this region. Through the study of effect, rather than cause, it is known that electron density in the upper atmosphere varies with altitude, time of day, season, latitude, and solar activity.

A more complete understanding of electron density in the upper regions will be determined through the *Topside Sounder* program by sending radio waves into the ionosphere from above and then by determining electron density as a function of altitude.

Such density maps already have been produced over the past 35 years by transmitting pulses from the earth with known but varying frequencies and by measuring the delay in return. However, these ground-based radio probes were able to reach only the maximum-density layer—about 200 miles altitude.

Recent sounding-rocket probes have indicated existence of ionized particles well above the F2 layer. These were all vertical-incidence type rockets launched before and during the IGY (International Geophysical Year); their results were extremely limited.

There are two dominant reasons for acquiring details of the topside electron density at all levels, said an AIL scientist:

1. The data are needed to improve prediction of the quality of high-frequency communication circuits, throug better understanding of the ionospher

2. The topside of the ionosphere—basic part of our near-space enviro ment—must be better known befo manned vehicles can be expected operate with any degree of equipme reliability.

• **Conceived in 1958**—The prese program was first conceived in late 19 by a special subcommittee of the Spa Sciences Board, directed by Dr. Booker of Cornell University. T board considered the feasibility of orbi ing an ionospheric sounder, and co cluded that it was encouraging.

Studies were continued throug 1959 by NASA's Goddard Space Flig Center, NBS-CRPL, AIL, and othe Near the end of 1959, AIL and CPR joined forces under NASA sponsorsh to design and develop the *S-48* satelli and conduct the required experiment

• **Four main objectives**—Orbitin a topside sounder should provide da in four areas:

—Electron density in the upp atmosphere at altitudes from 200 to 7 miles.

—Variations of these ionized-pa ticle densities diurnally, seasonally, a with changes in latitude and geoma netic disturbance.

—Plasma resonance frequency ne the sounder.

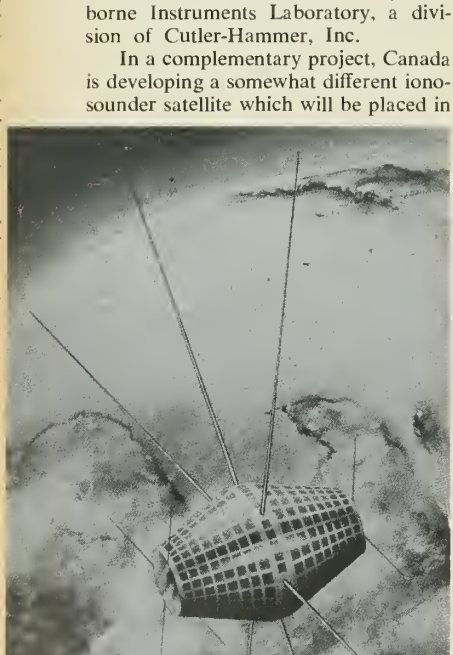
—Cosmic noise intensity in the 3- mc frequency range.

• **Rocket payload**—Main purpo of the *Argo D-4* was to test the sound equipment. The 48-lb. system includ a storage battery (28-v, nickel-c mium) power supply, single 2-frequen transmitter-receiver, a 2-channel FM FM telemetering subsystem, progra ming, and control equipment.

After attaining altitude, the nc cone housing the sounder equipme was to be spring-jettisoned to bring t telescoped antennas into operating p tion at right angles to the longitudi axis of the payload. Unfurled, the a tennas each extend 16 feet outward.

The payload was destined for altitude of about 700 miles. Altern pulsed transmissions at fixed frequenc of 4.07 and 5.97 mc were to be m repeatedly. Transmitter r-f output pow was to be about 35 watts.

Data received in the payload w to be transmitted over the VHF tele etry link to ground. The sounder p



LATEST NASA artist's conception of S-48, America's fixed-frequency Topside Sounder satellite, to be launched in '62.

vided three outputs: received signal strength, cosmic noise intensity, and echo delay time. Secondary objective of the rocket probe is the determination of electron density from 200 to 700 miles altitude.

This first firing was to be in the evening at a time when the ionosphere was considered "quiet" to minimize plasma-detuning of the sounder. According to a NASA spokesman, launch was to be soon after the time that radio penetration frequency of the ionosphere F2 region reached 6.5 mc on its diurnal increase, as observed from Wallops Island.

Another, similar sounding rocket will be launched soon during disturbed ionospheric conditions. The two shots are expected to yield sufficient data to support the satellite flights next year.

• **S-48 instrumentation** — Payload for the *S-48* satellite now under development will be packaged in two truncated cones, joined at their bases by a 40-in.-diameter x 6-in.-wide cylindrical center section. Length of the satellite will be about 3 feet. Weight is expected to be under 85 lbs.

Six dipole antennas, each nearly 33 feet long, will be erected after final separation.

The central canister within the payload will carry stacked telemetry circuit boards, the command receiver and radio sounder.

Each end of the satellite will carry the command, tracking, and telemetering antennas. The outer shell of the payload will be spotted with about 4000 solar cells for recharging the storage battery power supply.

Three dual frequency transceivers carried in the sounder will be used to transmit pulses sequentially at six fixed frequencies. These will be spaced logarithmically over the range from 3 to 15 mc. The transistorized r-f power amplifiers will probably have outputs well over 100 watts.

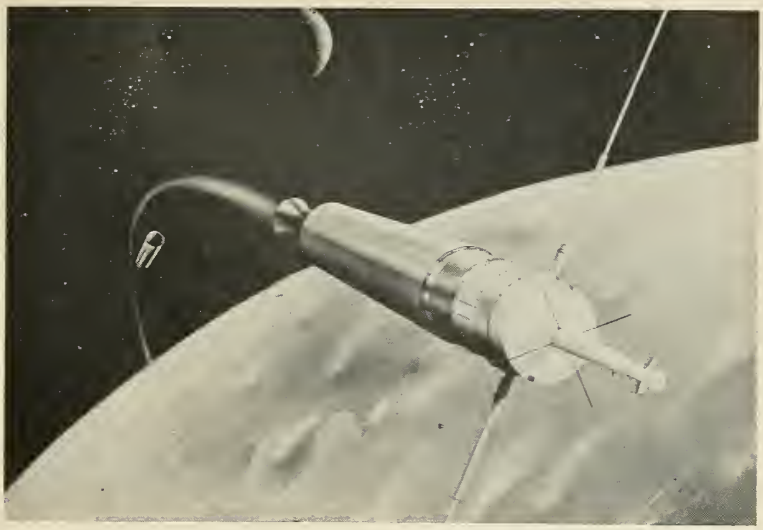
The satellite also will carry a tracking beacon and command receiver.

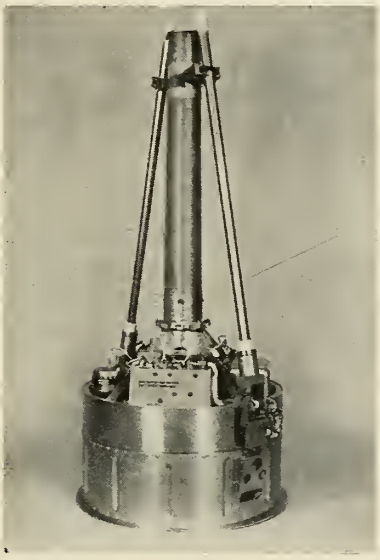
Design life of the *S-48* is from 6 months minimum to 1 year useful operation.

Launch will be by means of a NASA *Scout* booster from Pacific Missile Range into a circular orbit, at 80 degrees inclination, and at a proposed altitude of 700 miles.

• **Operation**—Each frequency will be transmitted from the dual-frequency transceivers for 100 microseconds. Then 15 milliseconds pause will be made for echo returns.

Each module in a transceiver will operate independently to enhance reliability. Frequencies selected will be such that none of the modules transmits adjacent frequencies in the 3-15 mc sequence. ⌗

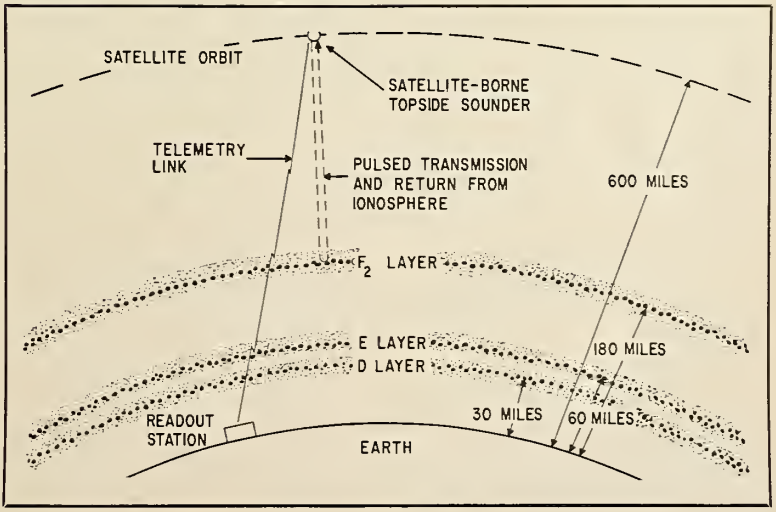




ABOVE: *Artist's rendering shows probe with antennas unfurled after jettisoning the nose cone at about 700 miles altitude.*

LEFT: *S-48 Topside Sounder development package built by Airborne Instruments Laboratory shown in unextended configuration. Central column supports spring to jettison nose cone. When clear, the telescoped antennas, clamped to center post, extend 16 ft.*

BELOW: *Diagram of principle of top-side ionospheric sounding. Following ground command, satellite sounder transmits radio pulses using six different frequencies.*



Nameless solid . . .

Big AF Booster to Cost $2 Billion

McNamara indicates single firm will get final award; Grand Central strengthens hand with new facilities

CONTRACTING for the *Nova*-scale Air Force solid booster is now expected to reach $2 billion within the next three years.

The Defense Department is indicating, moreover, that development and fabrication of the huge booster—presently billed as strictly a "backup" to NASA's liquid *Nova*—will be undertaken by a single company.

Test and development phase of the solid booster alone is expected to cost $500 million. Special facilities, including launch operations and fabrication, are expected to run an additional $1.5 billion.

No firm plans have as yet materialized as to how the program will be managed. Aerospace Corp. is expected to initiate the early study phase. But the Air Force says it has not decided upon an agency to run the program—although it presumably will be one of the divisions of the Air Force Systems Command. Nor has the project been given a name.

Major contenders for the big contract are the Rocketdyne Division of North American Aviation, Grand Central Rocket, Aerojet-General, United Technology Corp., and possibly Hercules Powder.

Defense Secretary McNamara, in newly released testimony before the House Defense Appropriations Subcommittee, said proposals may be solicited from two or four contractors. Apparently two contractors would then be chosen to do preliminary work—with one eventually named to carry out the project.

Study phase of the project is expected to extend through the summer and early fall. The critical decision on naming a contractor may come as early as December.

• **New giant?**—Depending upon how the competition comes out, a new giant could be born in the solid-propellant industry, presently dominated by Aerojet and Thiokol. In awareness of the size of the stakes, Grand Central Rocket is preparing to take a $10-$15 million gamble to beef up its facilities.

The company announced last week it is "going full speed" on the construction of curing and mixing facilities and test stands on a 5000-acre site in the mountains near Protrero, Calif. The facilities are to be ready in November—when the company expects the Air Force to conduct a survey of contractors to determine who is best equipped and qualified to carry out the project.

Other companies recently have decided to undertake expansion moves or have completed them. Aerojet has put a new continuous-mix plant on stream; Rocketdyne has purchased several thousand acres near Reno, Nev., for an advanced solid propellant research facility; and UTC is completing construction of a multimillion-dollar solid plant near San Jose, Calif.

The Air Force has this break-down of the $62-million downpayment for the program requested in President Kennedy's last revision of the FY '62 budget (M/R, June 5, p. 12): $50 million for RDT&E on the booster; $2 million for planning a test facility; $10 million to design and start construction of the test facility.

• **Noise hazard**—There is a question as to where the test stands and launchers for the big booster may be located. The Air Force feels a booster developing 2-to-3-megapound thrust will require clearances from populated areas of from 25 to 30 miles because of the noise level.

Cape Canaveral may be ruled out—unless some offshore facility is developed. Vandenberg AFB and the Pacific Missile Range's Point Arguello also may be passed over—either because they lack space or because of the polar trajectory problem. If an entirely new base is established—perhaps on the equator—an almost completely new range with ground instrumentation would be needed.

The $1.5 billion estimated for facilities by McNamara could provide funds for an entirely new launch complex—and a fancy one at that.

McNamara was asked whether the military solid-booster program related to *Dyna-Soar*. The defense secretary replied by leaving the door wide open:

"Not specifically at this time. . . . It is conceivable that at some point in the future our military requirements would necessitate placing a man in space, but we do not see any need for that in the immediate future, and we are not requesting the large booster for that purpose, but rather for the purposes of putting equipment in space."

For the moment, the big solid booster is regarded as complementing NASA's liquid *Nova*—and at some point about three years from now a choice may be made between the two. On this question McNamara told the subcommittee:

"I do not anticipate this will be done without considerable agony and controversy."

However, he avoided mention of the point that three years may bring considerable changes—which conceivably could justify both a liquid and solid program.

At another congressional hearing last week, attention was focused on the problem of public acceptance of NASA's manned lunar expedition. Sen. Warren G. Magnuson (D-Wash.) to NASA officials:

"As it stands now, it appears to the people and to Congress . . . that we are just making a jump to the moon."

In view of the cost, he added, "I think NASA has got to do a lot of missionary work."

NASA Schedules Apollo Industry Conference

NASA is holding an industry technical conference on the Apollo manned spacecraft in Washington July 18-20. The three-day session, classified confidential, will go into all phases of the system.

Presentations are to be made on the vehicle system, mission profiles, navigation, guidance and control, spacecraft propulsion, space environment, heating, onboard systems, landing systems, and crew participation. There also will be discussion of the design and operational aspects of Mercury as they pertain to Apollo.

A bidders' conference will be held about Aug. 1. A prime contract to design and build the Apollo spacecraft is expected to be awarded about next January.

60-man-year effort . . .

NASA Hunting for 6000 Recruits

Agency teams are missing no bets in 18-month drive to sign up scientists and technicians; salary gap is main problem

by Hal Gettings

NASA IS EMBARKING on a country-wide recruiting campaign of staggering proportions to fill an estimated 6000 positions during the next 18 months. Anticipating the large increases required by the accelerated space program proposed by President Kennedy, NASA Administrator James Webb says that the present effort must be increased by more than 50% in FY 62, and by almost 100% in FY '63.

Of the 6000 vacancies, some 2400 require engineers and scientists—a "hard" labor market at best. Technical people are needed in practically all 85 categories of "aerospace technology." Consequently, the current effort is a broad one and interviewers will talk to anyone whose qualifications fall anywhere in the area.

It is in the technical area that the recruitment program assumes its most impressive dimensions. On the basis of past results, recruiters will have to interview some 120,000 people to yield the desired 2400. Although NASA person recruiting costs are at the low end of the industry average—about $750 each—overall expenditure will total close to $2 million.

On the basis of one hour per interview, it will require some 60 man-years of effort to conduct the interviews. Since a recruiting team usually includes high-level scientific talent from the facility requiring personnel, the effort represents a considerable expenditure of valuable project time.

• **Salary gap**—Low salary scales are the toughest obstacle for NASA recruiters. A salary gap of up to $1000 exists between industry and civil service levels for BS degrees. This gap increases to above $3000 at the doctorate level. In some cases, PhDs can make twice as much in industry as in a comparable job with the space agency. As a result, NASA has found it impossible to hire PhDs fresh out of college. The majority of high-level scientific jobs at NASA go to scientists from other government agencies.

Some relief for this upper-level gap is in sight through legislation presently before Congress to increase the number of "excepted" positions. An amendment to H.R. 6874 would provide a total of 425 such positions, an increase of 135 over the present authorization of 290. This would allow annual salaries up to $21,000 for 30 positions and $19,000 for the remaining 395.

Webb, testifying last week before the House Subcommittee on Manpower Utilization, said the proposed increase "is essential to meet the critical staffing needs NASA must fill during the next 18 months." He pointed out that it is a matter "of considerable urgency" that NASA begin recruiting for these additional positions, "particularly in the projects affecting the manned lunar landing and nuclear rocket engine developments."

Congress will consider this request at the same time it considers the accelerated program of funding recommended by Kennedy.

No solution to the problem of recruiting lower-level technical people is near at hand, however. Although the salary gap is not so great for run-of-the-mill engineers, NASA still has a problem in competing with industry scales.

Even in areas of a "soft" labor market, recruiters have found rough going. In Cincinnati, for example—where General Electric has released hundreds of engineers and scientists due to cancellation of ANP contracts—interviewers had much less success than expected. They were able to attract competent individuals only "up to the point of salary offers."

• **Hole cards**—In spite of the problems, NASA is meeting with some success. One of its prime advantages is the challenge and interest inherent in space exploration. Robert Tiemann, chief of recruitment, says this is a big factor in attracting desirable personnel. In addition, he says, many persons have a commendable desire to serve their country. But he admits that such altruistic individuals are regrettably few.

NASA is not overlooking any possible personnel sources. The overall campaign is a multi-pronged effort that includes about every known recruiting gambit. In addition to conventional methods and areas of operation, NASA has several sources unavailable to industry.

One of the most fertile sources is the military. Through agreement with the services, NASA obtains a considerable number of highly trained officers on assignment. Such officers enjoy the relative freedom of civilian employment while retaining their military status and its inherent advantages. They wear mufti and are practically isolated from the military regimen. They are paid by their respective services, which are, in turn, reimbursed by NASA.

Foreign scientists are recruited through the Joint Operations Intelligence Agency of the Joint Chiefs of Staff. This provides a source of highly qualified PhDs unobtainable in this country due to the salary gap.

NASA also has a working agreement with the military for assignment of qualified ROTC officers for periods of 1½ to 3 years. The majority of these officers remain with NASA on completion of their active duty tours.

Professional conventions and meetings are worked hard by recruiting teams. These teams work both with the "career centers" set up at meetings and in independent recruiting operations.

Teams from the various NASA research centers and headquarters often coordinate their recruiting in intensive efforts aimed at particular population centers and areas where technical employment has been cut back. Cincinnati and the Dallas-Ft. Worth area have both been visited. San Francisco is next on the schedule, with other large cities to follow.

NASA also works with both U.S. and state employment services and does considerable college recruiting. A scheduled intensification of the college program is expected to yield 400-600 new graduates in the next year or so.

The personnel division has done much to streamline within the civil service recruiting procedure. They say that thanks to their coded job classifications and up-to-the-minute requirement lists very little time is required between interview and job offer. Normal time is two to four days, although this can often be shortened to one day. ⠿

NSIA meeting hears . . .

Pentagon Plans New Contract Approach

'Cost-plus-award-fee' expected to replace many 'cost-plus' R&D awards; more incentive-type contracts with bigger profit spread

by Hal Taylor

THE DEFENSE DEPARTMENT is planning to unveil a new "cost-plus-award-fee" contract within the next year.

Department officials said that the new contract—still in the idea-concept stage—will probably replace a large number of "cost-plus" contracts in the research and development field.

The outstanding feature of the contract, as revealed by Assistant Secretary of Defense Thomas D. Morris at a symposium of the National Security Industrial Association (NSIA), is the payment of an award fee ranging from −5% to 15% of the contractor's costs as estimated when the contract is drawn —after the contract is completed.

In other highlights of his address, which seemed to portend a minor revolution for DOD contracting, Morris said:

—The department intends to increase the use of "incentive-type" contracts in its programs.

—The spread of profits in incentive-type contracts should be increased from the present range of 4½% to 9% to, say, 0% to 15%.

Morris said that the ultimate award under the new contract "might be determined by a board of qualified judges made up of carefully selected professional people."

Their determination, he said, would be made after completion of the contract and would be based on total, overall performance, quality and reliability of the product, compared with original military requirements.

Morris noted that the board of judges would have to be impartial, professionally qualified people who would be appointed by the Secretary of the armed service awarding the contract. Decisions would be on the basis of demonstrated results.

• **The trouble area**—In calling for increased use of incentive-type contracts, Morris pointed out that while there has been a steady decline in fixed price contracts, the percent of dollars awarded under cost reimbursement (principally cost-plus-fixed-fee) contracting has risen from 13% of tota procurement in Fiscal Year 1951 t more than 42% in Fiscal Year 1960.

Of that $9 billion, he continue "only $672 million was under incentive type contracts." This area, Morris note represents one-third of total Defens Department procurement and "is th area where we must take steps to i crease incentives."

Morris said that the present spread in incentive-type contracts "do not giv the contractor a big enough incentive t go all out to reduce costs." He adde however, that they also do not impos "sufficient penalties for poor perform ance."

Morris said that DOD has had som initial favorable reactions to the pr posed "cost-plus-award fee" contrac "We feel," he continued, "that th would offer a challenge to industr leaders to demonstrate the abilities their companies to do a quality job- and to demonstrate this ability in suc a manner that a Board, not involved the contract, is convinced that a quali job has been done."

• **Approval** — A spokesman f NSIA—whose membership includ about 90% of DOD contractors—sa that the initial reaction of industrial o ficials at the conference was favorab

Industry feels that something mu be done to reduce costs of Defense D partment hardware and increase t profits of the defense industry, he c clared.

"We feel that if you only apply t profit motive to contracts you will sli into the cost problem pretty fast."

He added that while there is so question as to whether the new contra is legal, he felt that the Defense D partment would go to Congress to statutes changed, if necessary.

He noted that the seriousness w which industry views the effort to duce defense costs through the pr motive is sharply pointed up by speed by which it has moved to stu Defense Department recommendatio He said that NSIA's Program Advis Planning Committee scheduled a me ing for last Friday to start a study le ing to an industry position.

'We Will Not Tolerate . . . Inefficient Practices . . .'

SECRETARY OF DEFENSE Robert S. McNamara served notice last week that the department is serious in its efforts to reduce the costs of defense programs.

He told a symposium of the National Security Industrial Association (NSIA) that "we will not tolerate, we will not accept, we will not sponsor uneconomical and inefficient practices, whatever their source and whatever their intention."

Calling on industry to cooperate with the department in increasing the cost benefit ratio in defense contracting, Secretary McNamara suggested that industry and government must work to:

—Simplify specifications and rationalize tolerances in contracts.

—Reduce development time through real analysis, and sometimes by a drastic overhaul of decision-making processes.

—Obtain more reliable cost estimates.

—Control engineering changes after an item has gone into production. It is essential that the improvement arising from an engineering change be worth the cost.

—Simplify Defense Department procurement and the procurement procedures used down through all the tiers of the subcontracting structure.

—Streamline the reporting requirements imposed by the Defense Department. As an example, he said, in requesting maintenance information it is frequently unnecessary to provide exact dimensions or processing data on component parts.

—Eliminate uneconomic and inefficient conditions, whether imposed by management or labor.

"These seven problem areas are only examples of the many fields in which we can find opportunities for cost reduction. I am aware that some of our internal policies, procedures, and methods of operation make industry's job more difficult. Some of these can be modified, and efforts are under way to achieve these modifications," Secretary McNamara said.

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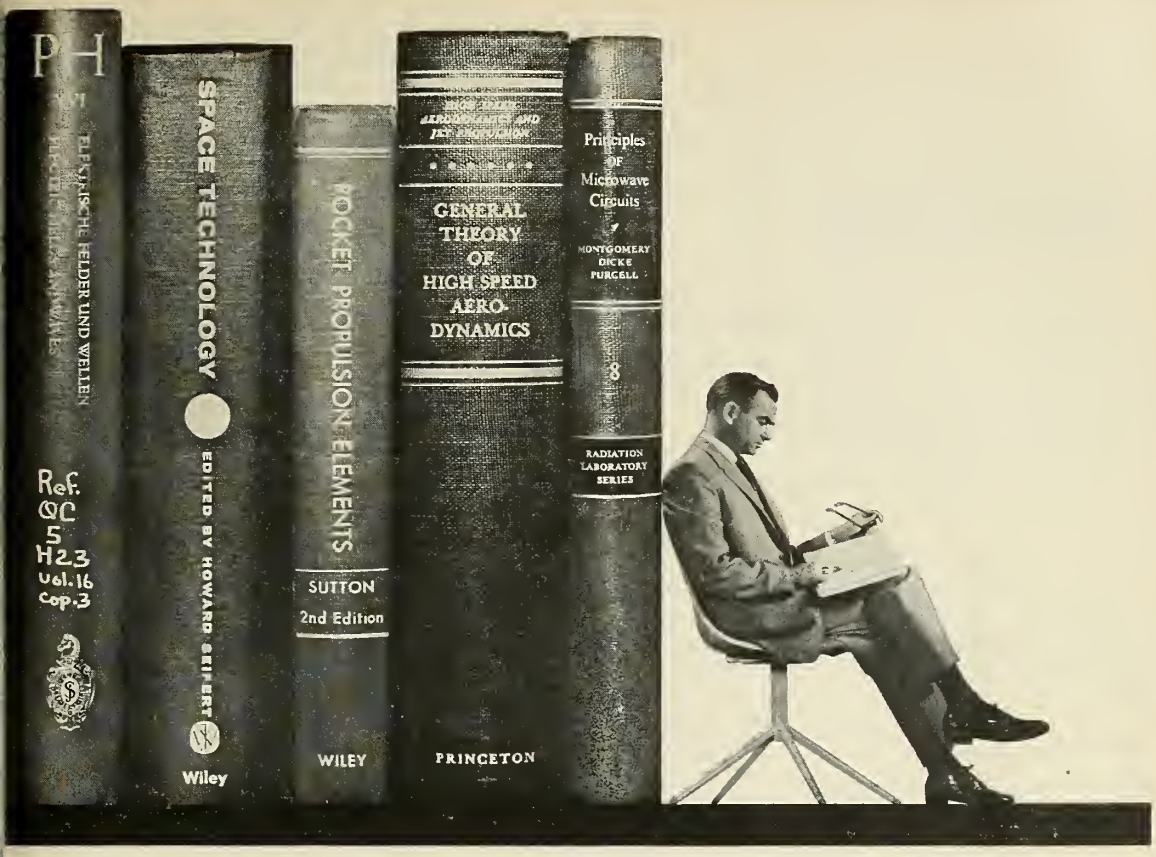
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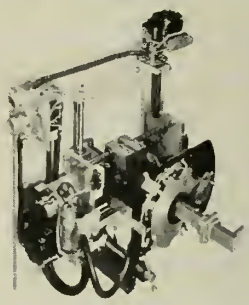
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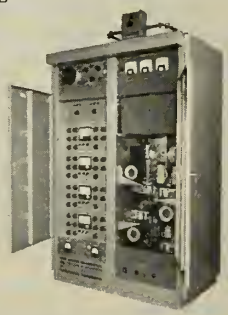
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Technical Countdown

SUPPORT EQUIPMENT

Wallops Tracking Net to be Updated

NASA will update its Wallops Island, Va., space-probe racking facility with $300,000 worth of new equipment. Under a contract with Cubic Corp., three AGAVE acquisition id and telemetry systems, a master control console, and a 50-ft. boresight tower for tracking system calibration will e added.

Air-Trailer to Ferry Space Vehicles

A unique "air-trailer" is being proposed as one possible olution to the problem of transporting large space vehicles. As conceived by Ling-Temco Electronics, such a craft would e a large glider attached to its tow plane by a semi-rigid ow bar. One model on the drawing board would be 160 ft. ong and have a wingspan of 210 ft. It could carry loads 24 t. in diameter, 90 ft. long, and weighing up to 50 tons.

New Data Transmitter Revealed

ACF Electronics will soon demonstrate its new communications system for handling the high-speed simultaneous ransmission of digital data from multiple sources. The expandable modular system is adaptable to all types of existing eleprinters, facsimile machines, etc., for transmitting over a ngle standard telephone line at rates up to 4800 bits/econd. As many as 16 different machine inputs can be handled at once, the division claims.

Big Wind at El Segundo

Douglas Aircraft's new hypersonic wind tunnel—capable f mach 10 velocities—became operational last week at the l Segundo Aerophysics Laboratory. The $2-million facility -the largest industry-owned tunnel in the U.S.—can test ircraft and missile models up to 36 in. long and 6 in. diamter. Tremendous high-pressure storage tanks give the tunnel st-run durations of up to four minutes.

Alaskan Air Defense Strengthened

Recent additions of electronics air defense coordination ystems (ADCS) to the Alaskan Command are now fully perational. Each ADCS is composed of one Army air dense system, one AF interceptional control system, and a entral tactical console. Target data from acquisition radars e funneled into the operations central for display, and to l battery units. The air defense commander can monitor e overall situation and assign targets for either missile or rcraft interception.

ADVANCED MATERIALS

Windows to Lighten Satelloons

The weight of balloon satellites can be reduced by about 0% by chemically milling a pattern of circular windows—lightening holes—in the aluminum coating of the plastic heres. The network of aluminum remaining will preserve e desired rigidity of the sphere in space, according to G. T. hjeldahl Co., which is investigating the development for ASA.

New Plastic to Up Rocket Performance

Operation of rocket engines at temperatures up to 0,000°F may be possible with new plastic materials and self-cooling techniques. A new composite of ceramic, refractory, and plastic—being developed by Hughes Aircraft for the Air Force—is expected to resist even supersonic rocket exhaust velocities for several minutes and result in higher-performance aerospace propulsion systems.

PROPULSION

Conical Solid Out?

The originators and principal promoters of the conical solid-rocket concept, United Technology Corp., told a joint Army-Navy-AF meeting in Denver recently that if the government wanted to buy a large solid rocket from UTC, the final product would have a zero-degree taper. In other words, it would have to be cylindrical.

New Pluto Reactor Design Complete

Lawrence Radiation Laboratory has completed design of the *Tory IIC* reactor for Project *Pluto,* and is now fabricating components. Reactor for the nuclear ramjet is full-scale missile size, rather than a scaled-down model such as the small *Tory IIA* initially used. Tests of the *IIC* will involve about one million pounds of air, heated to 1060°F, and will dispense with water-cooling used in first runs. LRL says it expects additional problems to crop up during testing, but is encouraged by progress made with *IIA*.

ASTRONAUTICS

Glider Best for Re-entry?

Maneuverable space gliders offer advantages in flexibility, comfort, and safety that make them the best choice for re-entering the earth's atmosphere after deep-space missions. But two Boeing Co. engineers who advocate the glider say it might be too heavy for any rocket currently in use, and would have to await further booster development. Also, the greater heat generated by a glider vehicle on re-entry would require advanced concepts for heat protection.

Exploding Cannister to Carry Echo

Echo balloon satellites will be packed for their trip into space in magnesium containers designed to explode apart after ejection. Separation of the two halves of the container by a shaped charge will free the 500-lb., 135-ft. sphere to be inflated and orbit the earth as a communications reflector. Grumman Aircraft will build the containers for NASA.

Space Roles to Be Divided?

Some industry observers foresee eventual resolution of current Air Force-NASA battle over space missions through NASA returning to its pre-*Sputnik* role of research organization while Air Force—and possibly commercial firms—conduct hardware portions of space activities. Some research-minded factions in NASA are reported to welcome such a possibility as a step toward regaining the integrity established during years of detached "no-axe-to-grind" activity.

Centaur Schedule Affects Mariner

Changes in *Centaur* vehicle status are being evaluated by Jet Propulsion Laboratory as to the effect upon its planetary exploration program. Greatest effect is expected to be felt in *Mariner* shots at Venus. Other programs probably will stay on schedule.

Curtiss-Wright Deep in Motor Cas

Experience in metallurgy spawns fresh approaches to problem of containment of energetic solid fuels

by John F. Judge

WOOD-RIDGE, N.J.—Lessons learned in more than 45 years of metallurgical experience are cutting the expense of fabricating *Minuteman* and *Pershing* motor cases at the Wright Aeronautical Division of Curtiss-Wright Corp.

One technique eliminated pre-heating in the critical weld areas of the *Minuteman* case. This simplified the process by removing the need for heated, expandable mandrels, and reduced tooling and equipment demands —all of which means increased production speed and lower unit costs.

The firm has never had a case rejected or returned by Thiokol Chemical Corp., prime contractor for the first-stage *Minuteman*. Several weeks ago, a case was pressure-tested to burst, and the failure agreed with prior theoretical considerations. The break occurred in the base metal area—15.5% above the uniaxial burst level indicated by the Von Mises theory.

Work now under way will lead to automation of blast tube welding on aft closures. This complex joining job is currently being done by hand. Reducing it to automated techniques will increase the reliability and efficiency of the welds.

There is full metallurgical coverage through every step of the complicated fabrication, even though some of the segments are entrusted to outside vendors.

High-performance cases have been almost entirely fabricated from machined forgings of D6 steel, but WAD is moving swifty into the roll-forming method. Roll-forming, or shear spinning, drops the number of discrete cylinder sections in each case from five to two; facilities available at Hufford Corp. may make one-piece *Minuteman* casings a reality.

Roll-forming reduces the expensive raw material requirement for a first-stage motor case by 75%. WAD is already incorporating roll-formed sections into production cases.

Shear spinning is not new to WAD engineers and metallurgists. The division had been developing spinning methods for the Air Force's Air Material Command two years prior to motor case applications.

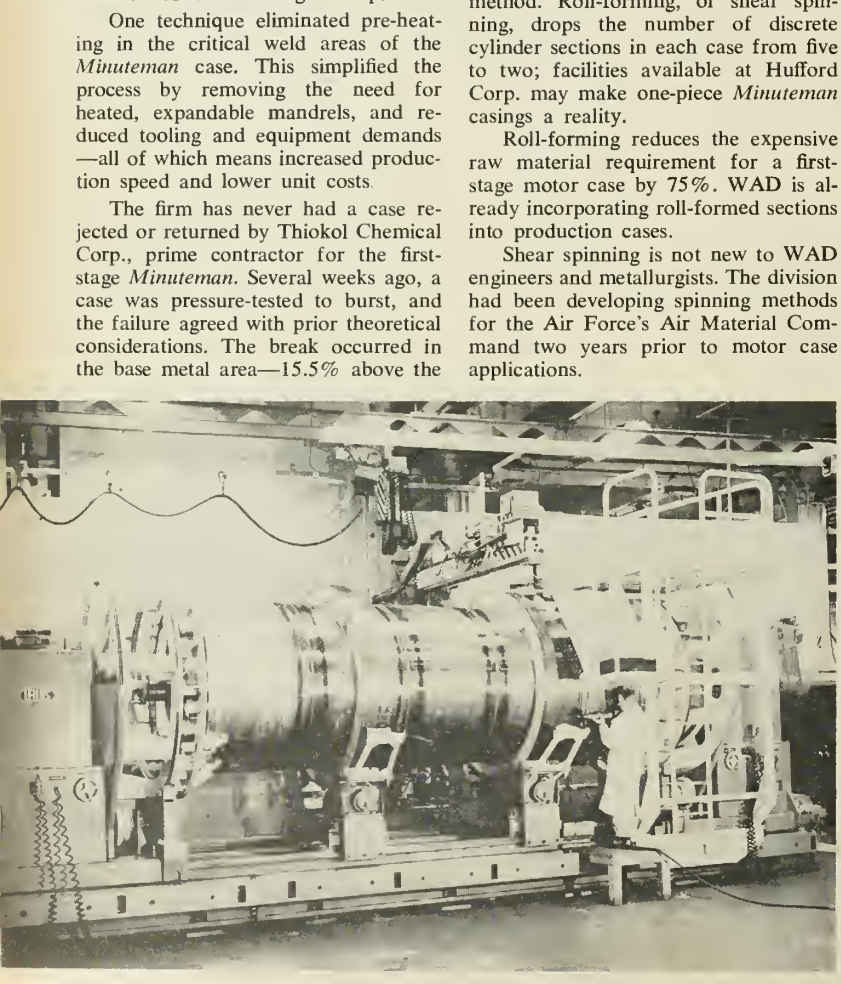
• **Functionally facilitized**—The *Minuteman* and *Pershing* production facilities are currently in a state of flux at WAD. New machinery is being installed and existing apparatus is being shifted. This improvement in production flow is being accomplished without interrupting the division's motor-case output.

The Navy's Program Evaluation and Review Technique (PERT) with an IBM program schedule has been adapted to the *Minuteman* project at WAD.

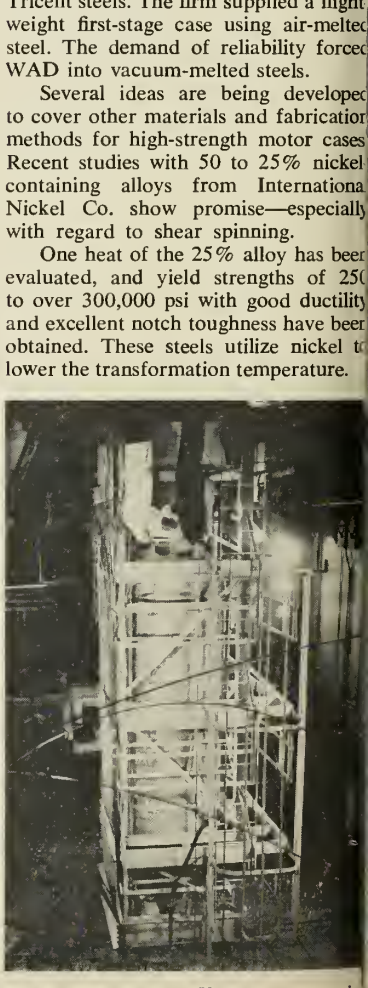
Early *Minuteman* work at WAD involved exploring a number of alloy compositions and fabrication techniques. Materials included were 4130, 6428 and Tricent steels. The firm supplied a flight weight first-stage case using air-melted steel. The demand of reliability forced WAD into vacuum-melted steels.

Several ideas are being developed to cover other materials and fabrication methods for high-strength motor cases. Recent studies with 50 to 25% nickel containing alloys from International Nickel Co. show promise—especially with regard to shear spinning.

One heat of the 25% alloy has been evaluated, and yield strengths of 250 to over 300,000 psi with good ductility and excellent notch toughness have been obtained. These steels utilize nickel to lower the transformation temperature.



AUTOMATIC WELDING the segments of the Minuteman first-stage motor case. Curtiss-Wright has developed a technique that eliminates the necessity for pre-heating.



BURST-TEST tower. Unique, conservativ static test uses oil instead of water.

echnology

In addition, aluminum and titanium re added to allow further adjustments f transformation temperature, depend-ıg on whether these elements are dis-olved in or precipitated from the iron-ickel solid solution.

• **Reaching for 300,000 psi**—Beside ıe high yield strengths of the 25% ickel steel, remarkable notch tough-ess has been observed. In one case, an xperimental pressure vessel burst at 78,000 psi (based on S = PR/T). ut a large forging lap which extended .052 in. through the 0.070-in. wall was iscovered after ductile failure along ıe entire length of this vessel.

Shear spinning methods are particu-ırly suited to the 25% steels. It has een found that large increases in ten-le properties of conventional rocket-ase steels can be achieved by interrupt-ıg the quench from the austenitizing mperature and deforming the steel hile it is still in the austenitic condi-on. This means using the shear spin-ing process to warm-work the metal— 800 to 1000°F.

With the 25% nickel steels, the eformation of the austinite prior to ansformation can be done at room mperature.

In the conventional steel, girth welds ould not attain the benefits of the warm-working because the welding is done after the working and the heat of welding would remove the warm-worked properties in the areas adjacent to the weld.

This pitfall can be avoided in 25% nickel steels, say WAD specialists, by locally cold-working the weld joint through shear spinning as the welding assembly of the case progresses.

WAD metallurgists caution that there are still problem areas in the nickel steels and that the development is still in the early stages.

Another wrinkle being pursued in the development labs at Curtiss-Wright is the potential of helically interlocked titanium tape-wrapped pressure vessels. The tapes have "I" beam and channel cross-sections and are wound on a removable mandrel so that they lock each turn with the preceding turn.

The interlocking tape concept avoids the welding problem inherent in B120VCA titanium alloy. In addition, cold-working the base weld wire material into the necessary cross-section brings the strength level of the metal up to 300,000 psi—which, if fully utilized in a motor case, would result in a strength-to-density ratio of about 1.7×10^6 in.

The final tensile strength of 250,000 to 300,000 psi is obtained by aging at 700-750° for 12 to 25 hours, depending on the extent of cold reduction.

Fore and aft sections are wound into the vessel by grinding similar interlocking features into the solid closure.

Like the nickel steels, the tape-winding method is still in development. Wright Aeronautical received support for the project from the Army's Ordnance Materials Research Office.

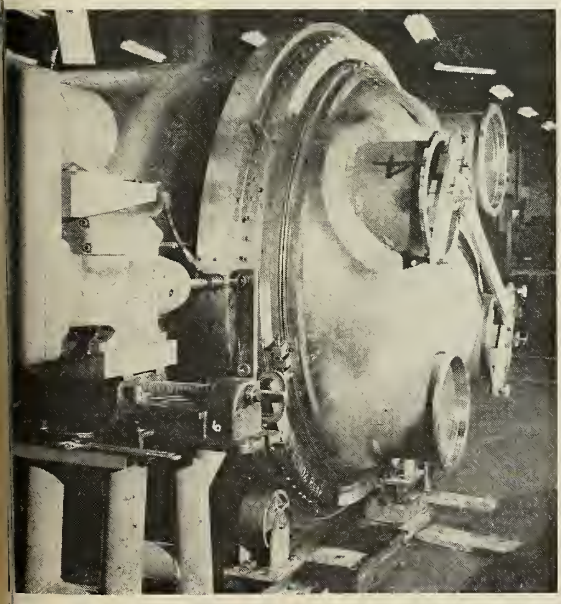
• **Vapor-deposited cases**—Even further back in the research stages is a series of studies on the application of thin-film technology in metals to motor cases—which could increase their strength by a factor of 10 over current materials.

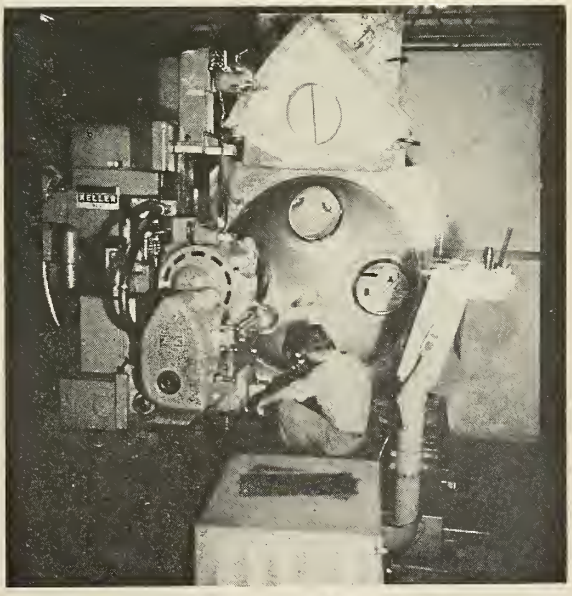
Work performed at the University of Virginia has shown that as film thickness goes down, a point is reached at which the strength increases abruptly. WAD is sponsoring research conducted in this area by the Brooklyn Polytechnical Institute, under direction of Professor Carmine D'Antonio.

The basic idea is to build up several thousand layers of thin-metal films, possibly deposited on the inside of the motor-case mold, to a total thickness of about 0.020 in. To retain the high strength, each layer must remain discrete from the next so some suitable coating material, such as an oxide, must be applied between each film segment.

Curtiss-Wright is not restricting its capability to motor cases—either in the current state-of-the-art or beyond. The Wright Division has over 1000 engineers and it is still hiring. Metallurgy alone accounts for over 112 engineers. Corporate energy is being expended in the field of nozzles for large solid rockets, and in other areas related to the missile/space field.

One current program at Fansteel Metallurgical Corp. involves the spinning of tungsten sheets into cones. Ultimately, complex nozzle shapes will be fabricated, reduced on a mandrel at 2000°F. Long-range plans include materials programs in reinforced plastics, steel, and graphite. ⌗



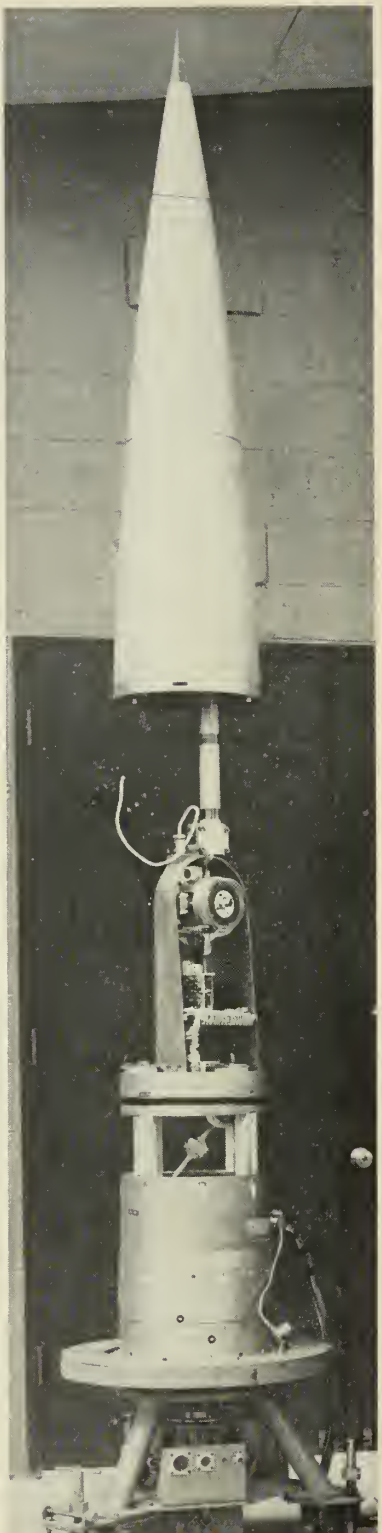


EFT: *Drilling holes in aft section of Minuteman first stage. ccuracy depends on relationship of blast ports, geometrical center of case, other factors.* **RIGHT:** *Trace-machining aft closure—a job done by subcontractors.*

First Details of OAO No. 3 Experiment

Princeton - directed project will collect data by rocket to help determine satellite payload; test shot this week

by Charles D. LaFond



FIRST TEST of Aerojet-General attitude control system used in Aerobee rocket probes for developing astronomical satellite instrumentation will be attempted again this week. An earlier NASA launching attempt in March failed. Here is view of sun-seeking control system developed by Ball Brothers to check out Aerojet's control system.

FIRST instrumented probe in the stellar-ultraviolet radiation study for National Aeronautics and Space Administration is scheduled for May 1, 1962.

Each of three *Aerobee 150A* sounding rockets to be used in the initial program will carry a newly developed, very accurately aimed spectrometer. The equipment tests and the data recorded will provide early information for a follow-on UV-satellite study in late 1965. This will be the third experimental vehicle in the Orbiting Astronomical Observatory program.

Both the rocket probe study and the *OAO No. 3* project are under the direction of Professor Lyman Spitzer, Jr. Princeton University Observatory.

The initial rocket-study contract awarded to Princeton by NASA in October, 1960, reportedly totals "several hundred thousand dollars." The ultimate *OAO* project is funded by both NASA and Air Force for an undisclosed amount.

Preliminary work leading up to the initial contract was performed by Princeton with University funds.

• **New attitude control**—The *Aerobee* rocket to be used in the future stellar probes will carry a highly advanced attitude or pointing control and de-spin systems.

Since the rocket will be used as a test bed for developing many of the astronomical experiment instrumentations for the *OAO* program, three-axis stabilization is essential.

The 44-lb. control system was developed for NASA by Aerojet-General Corp. in Azusa, Calif. It is a 2-gyro referenced, inertially programable system using cold-gas-jet reaction for control. The pair of free gyros—one for pitch and roll, one for yaw—serve as the key inertial sensing elements. Up to five spatial targets can be programed for each flight.

In the control system, pitch and yaw jets and solenoid-actuated valves are located in the tail cylinder, about the sustainer nozzle. Components for roll control and de-spin are installed with guidance intelligence sub-systems in a rocket nose extension, approximately 6.5 in long. Helium will be used in the reaction units.

Six sets of valves and nozzles will provide bi-directional control about each axis. One set of roll nozzles are used for de-spinning the vehicles after burnout—51 seconds after launch and at roughly 25 miles altitude.

• **Another test due**—The two-stage vehicle will be launched this week in another attempt to check out control. First try failed last March.

Again the vehicle will have a near-vertical trajectory. Maximum expected velocity is 6100 ft./sec. Its near-200-lb. payload will reach a peak alt

ude of about 135 iles.

Instrumentation in his next shot will probbly include units for easuring solar-flux in vo spectral regions. hese will be centered t about 2200 and 2600 ngstroms with a 100-00A bandwidth. Sen-ors are two photo-missive cells employ-ig cesium - telluride athode and appropri-te optical filters.

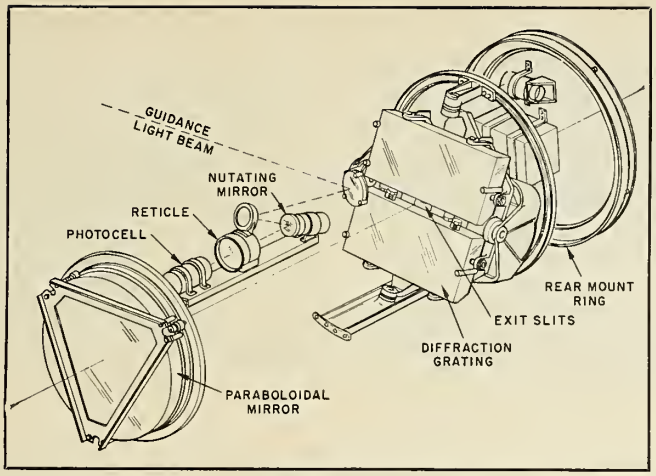
A second experi-ent also will encom-ass measurement of ergy in space. This ill be a detector for taining data on the ergy and distribution gamma rays in the 1 and 1.5 million elec-on volt region.

Both experiments are considered sec-dary in importance to the testing of e attitude control system.

Included in the payload will be a acking solar-aspect sensing system. eveloped by Ball Brothers Research orp., Boulder Colo., the sun seeker ill be used to check out the Aerojet titude control package. The device will aligned to the control system axes d provide a means for measuring the gle between the solar vector and the ngtitudinal axis of the rocket. it sup-ies both a fine and coarse alignment.

In case of primary system failure, a ck-up for the solar-aspect sensing sys-m will be included. This will consist two magnetometers for sensing orien-ion to the earth's magnetic field.

• **Spectrometric study**—Next May, e first spectrometric measurements hot-star ultraviolet radiation will be empted.



UV SPECTROMETER and fine-positioning optical system used to align the diffraction grating. Developed by Perkin-Elmer for Princeton University Observatory, it will be carried in Aerobee 150A rockets for high-altitude stellar study.

The instrument to be used is currently being built for Princeton by Perkin-Elmer Corp., Norwalk, Conn.

In less than 5 minutes, at an altitude of 62-143 miles, the spectrometer will scan wavelengths from 1000 to 3000 Angstroms at approximately 30A/sec. Resolution will be about 2A.

The lightweight, low-power system, according to P-E, is designed for maximum simplicity and reliability. The complete package will measure 14 in. dia. x 30 in. long.

The first star selected for analysis is Alpha Birginis (Spica).

If all goes well with the attitude control, UV radiation from Spica will enter the system through an aperture in the rocket cone. Since the light source is stellar, radiant energy will arrive at the spectrometer already collimated.

The light passes through a diffraction grating (see drawing), and is then focused on a pair of photomultiplier - detectors, each scanning about 16A/sec. simultaneously. Photon-count signals are then amplified and telemetered to the ground receiving station for recording.

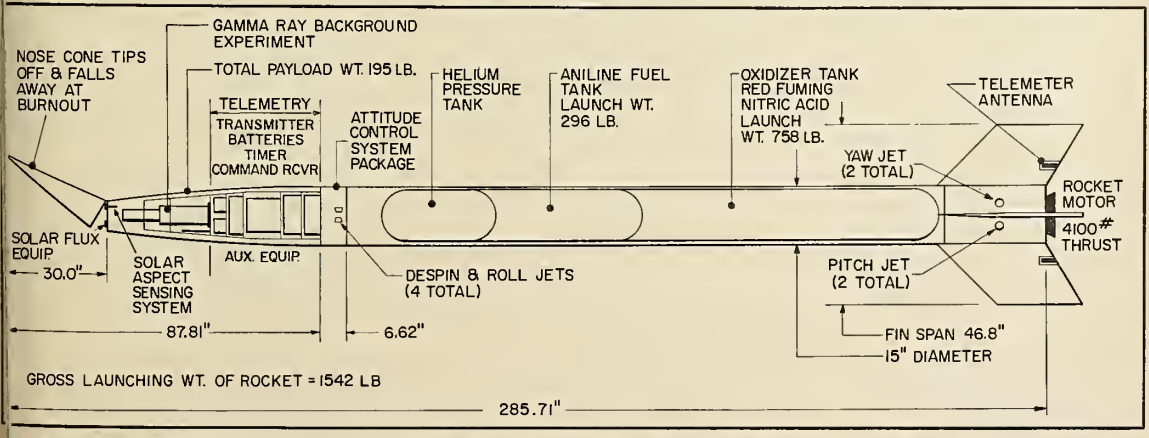
Accuracy of the Aerojet attitude control, according to Dr. J. Rogerson, assistant project director at Princeton, is designed to at least ±1.5 degrees. The P-E spectrometer, however, will have its own line positioning capability. It will permit a grating alignment normal to the incoming light to an accuracy of better than ±10 sec. of arc.

The fine adjustment system is a two-axis type using a simple but accurate rotating-image technique. Locked in place during powered flight, it is activated when the star under study is acquired.

Light is reflected by a mirror (mounted with the diffraction grating) to a rotating mirror, then directed through a reticle. Segmented into a "sun-burst" pattern, the reticle breaks up light passing through it according to amount and direction of position error.

This modulated light is focused on a phototube. Data are converted to error signals by a frequency-modulated discriminator and resolver. Error signals fed to a servo system are used to adjust the axes of two spectrometer gimbal ringmounts and thus position the diffraction grating.

Results of these early rocket studies will help determine type, size, and accuracy of future instrumentation which must be developed for *OAO No. 3.* ⁂



AGRAM OF AEROBEE 150A instrumentation configuration testing a new attitude control system and for measuring solar flux and gamma-ray energy levels in space. NASA expects to launch the vehicle this week.

NRL Process Cuts Fire, Flood Damage

Cleaning technique has already saved millions of dollars in refitting burned carrier and is changing military's 'scrap it' policy

by William Beller

A NAVY-DEVELOPED chemical process is pointing the way to salvaging instruments and equipment usually considered lost when a factory is swept by fire or flooded.

The process has recovered several million dollars worth of electronic and electrical apparatus damaged by sea water, fuel oil and smoke during a fire on the carrier USS Constellation last December. Nearly all the communications and fire-control equipment not actually burned was fully reclaimed and put back into service.

Some users are so enthusiastic about the process that they are suggesting outfitting trailers which would rush to disaster areas to begin salvage operations.

• **100% loss**—When electronic or electrical gear is soaked with water—especially sea water—military doctrine has been to scrap it. Experience showed that when such equipment was "rehabilitated" its reliability was so low it could not serve a military mission.

It is still common practice to declare useless the electronics in "dunked" aircraft and in missiles aborted over water.

Also, because the reliability and accuracy of communications and radar equipment is so quickly undermined by salt spray aerosols—which are part of the environment aboard ship or at coastal locations—the electronics must be either carefully and expensively protected or frequently replaced.

In such instances of possible corrosion and water damage, the Navy process has resurrected military equipmen with almost incredible effectiveness Cleaners get rid of corrosion, fuel oil soot and even some "varnish"; then water displacer rapidly and activel chases the water from all the surface and interstices of the equipment.

In a graphic demonstration of th water displacement action, a ball o steel wool is first immersed in wate Then it is removed and sprayed with th water displacer. If conditions are right in a few moments a clump of wate drops out of the steel wool, which excep for a protective coating is left bone dr

When the USS Constellation damag was first surveyed, it was estimated tha it would take a year to put the carrie back into service. This included the tim it would take to replace most of th

First Aid for Salvaging Electrical, Electronic and Mechanical Equipment

BEFORE REMOVING any equipment from fresh or sea water be sure that preparations have been made to proceed immediately with salvage operations. If the equipment cannot be cleaned immediately, it should be flushed with fresh water and thoroughly sprayed with the water-displacing fluid at the earliest possible mament.

If the only surface contamination is fuel oil or similar material and sea water, the equipment may be flushed off with fresh water and carried immediately into Step 1 below.

If severe tarnishing or corrosion is encountered on small areas of the equipment, the corrosion products may be remaved by a treatment of a minute or less in an ultrasonic bath containing inhibited sulfamic acid solution. This shauld be followed immediately by a freshwater rinse, an alkaline neutralizing bath, and a final flushing with fresh water. The equipment should be carried immediately into Step 1 of the salvage procedure to remove the final traces of the stronger cleaning agents used in the auxiliary treotment.

Heavy sludges and greases may require the use of alkaline cleaners such as polyphosphates or silicates before Step 1.

Step 1. *Spray the exterior of the equipment thoroughly with the cleaning emulsion to remove as much contaminant as possible. Flush the equipment with fresh or sea water. If access can be gained to the interior of the equipment, spray the interior thoroughly, then flush it with water. If the construction of the equipment prevents access to the interior, disassemble and spray the interior thoroughly, then flush with water.*

Step 2. *After most of the oily contaminant has been removed by the flushing process, the last traces of contaminant and sea water can be removed from the equipment by subjecting it to the cleaning emulsion in an ultrasonic cleaning tank. This treatment is particularly effective in removing contaminants from crevices and narrow clearances. The ultrasonic cleaning treatment is carried out as follows:*

a. Disassemble the equipment as far as necessary to gain ready access of liquid to all remote locations.

b. Immerse the parts in the tank of an ultrasonic cleaning apparatus containing the cleaning emulsion.

c. Flush with fresh water; then repeat the ultrasonic treatment using fresh water to remove excess cleaning emulsion.

Step 3. *Blow as much water as possible from the equipment with clean compressed air.*

Step 4. *Spray all parts of the equipment with the water-displacing fluid. After spraying, allow 20 minutes for the water-displacing fluid to penetrate, displace and combine with th water remaining in the equipment.*

Step 5. *The residual mixture of water an water-displacing fluid should be evaporated an oven or by hot air.*

If there is no fuel oil or lubricant contamin tion, omit Steps 1 and 2 and start the solvo procedure as indicated in Step 3.

Mechanical equipment is ready for operatio after a thorough lubrication. After starting o equipment it should be operated for sever hours under no load or very light load to secu gentle internal heating to complete the dryin

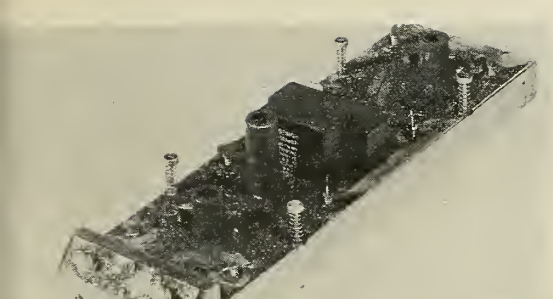
The following precautions should also be o served in all salvage operations:

—Journal bearings—remove waste packin in bearing chambers, clean as directed for oth equipment above, add new packing, and sa rate with suitable lubricant.

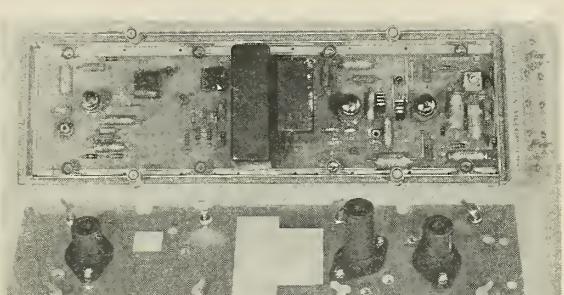
—Ball and roller bearings—remove greo either by disassembly and cleaning or by forcin new grease through bearings until all old greo has been displaced.

—Carbon brushes—replace carbon brush in generators and d-c motors.

—Contact points in switches and relays remove the rust-inhibiting film left from t water-displacing fluid by wiping joints with lin less cloth soaked in naphtha solvent or eth alcohol.



BEFORE: *Frequency converter heavily damaged by fire.*



AFTER: *Interior view shows thoroughness of cleaning.*

vater-damaged, soot-and-oil-covered lectronic and electrical gear.

• **Assembly-line cleaning**—Chiefly ecause of the cleaning process used on his gear, the carrier is expected to sail ive months sooner. The process was in ssembly line operation earlier this year t the New York Naval Shipyard in Brooklyn.

Components, racks of equipment nd even consoles entered the line vater-logged and smoke-blackened—nd exited glisteningly clean and ready o function after minor replacements nd adjustments.

In this assembly-line process, the quipment is first flushed out with fresh vater. If necessary, it is ultrasonically reated with an aggressive cleaner to re-nove adherent particles. Then it is ither bathed in an ultrasonic tank con-aining a Navy-developed cleaning mulsion or sprayed with it. This emul-ion removes mobile contaminants such s fuel oil and smoke residue as well as ea water and sea-water corrosion roducts.

Next, the equipment is thoroughly ushed with water—either ultrasonically r by spray—to remove the cleaning mulsion and any traces of salt.

After flushing, the bulk water is lown away by clean compressed air. he water still remaining is physically ushed aside by a spray of water-dis-lacing solution, which also deposits a in anti-corrosion film. Any water that oes remain—in deep crevices or within oil windings—combines with the water-isplacing solution to form an azeo-rope, which is a fluid having a lower oiling point than water. Thus, when an zeotrope evaporates, it takes the water ith it.

Finally, the equipment is warmed ther by an oven or hot air to evaporate ie residual mixture of water and water-isplacing fluid.

• **Water go away**—The two chem-als that make the process so effective –the emulsion cleaner and the water displacer—were formulated at the Naval Research Laboratory, with the support of the Navy's Bureau of Ships, in a program that goes back nearly 18 years.

At the time, a BuShips design engineer Earl Palmer wondered if something could be done to prevent the total loss of electrical equipment being raised from the ships sunk at Pearl Harbor. He suggested the problem to NRL chemist Dr. W. A. Zisman, already well known for his work in lubricants and surface chemistry. Zisman in turn brought his associate, H. R. Baker, into the project.

They started their study with a phenomenon that had been discovered more than a century earlier: if a little alcohol or some other polar volatile fluid is dropped on a wet surface, the water is pushed aside—but it flows back again.

The two chemists wanted an organic substance that would not only push water away, like alcohol, but would also keep it away.

After a scientific search of about a year, Zisman and Baker found a composition—butyl alcohol plus three percent basic barium dinonylnaphthalene sulfonate—that would successfully displace sea water. This was patented, and is being commercially produced under the trade name Spradri by the Perfecting Service Co., Charlotte, N.C.

Getting sea water out of electronic equipment is only one phase of the problem. When a ship's compartment is pierced—by collision or torpedo—the fuel bunkers are often ruptured. When the flooded compartment is drained, everything in it is found covered with a thick, tar-like blanket of black oil. Any attempt to salvage the equipment is usually considered doomed.

• **Displacing fuel oil**—Then in 1956, NRL revived the water-displacing problem—this time seeking an agent that would displace fuel oil.

Three years later, Baker and NRL chemist Dr. C. R. Singleterry reported the formulation of the water-based emulsion that was used to help clean the USS Constellation's gear.

The cleaning process is said to have no detrimental effects on electrical insulations, plastics, protective varnishes or adequate solders. Curiously, the process will often open a cold solder.

Dr. Singleterry points out that common sense is one of the main ingredients in the process. Salt-water-soaked equipment should be flushed out as soon as possible to prevent corrosion. Then the appropriate treatment should follow.

For the sake of economy as well as efficiency, the process should be varied with the degree and kind of exposure experienced by the equipment. If this is done, and if ordinary salvage precautions are taken, then sea water and bunker oil, fire and flood, will be claiming relatively smaller tolls of electronic and electrical gear. ❖

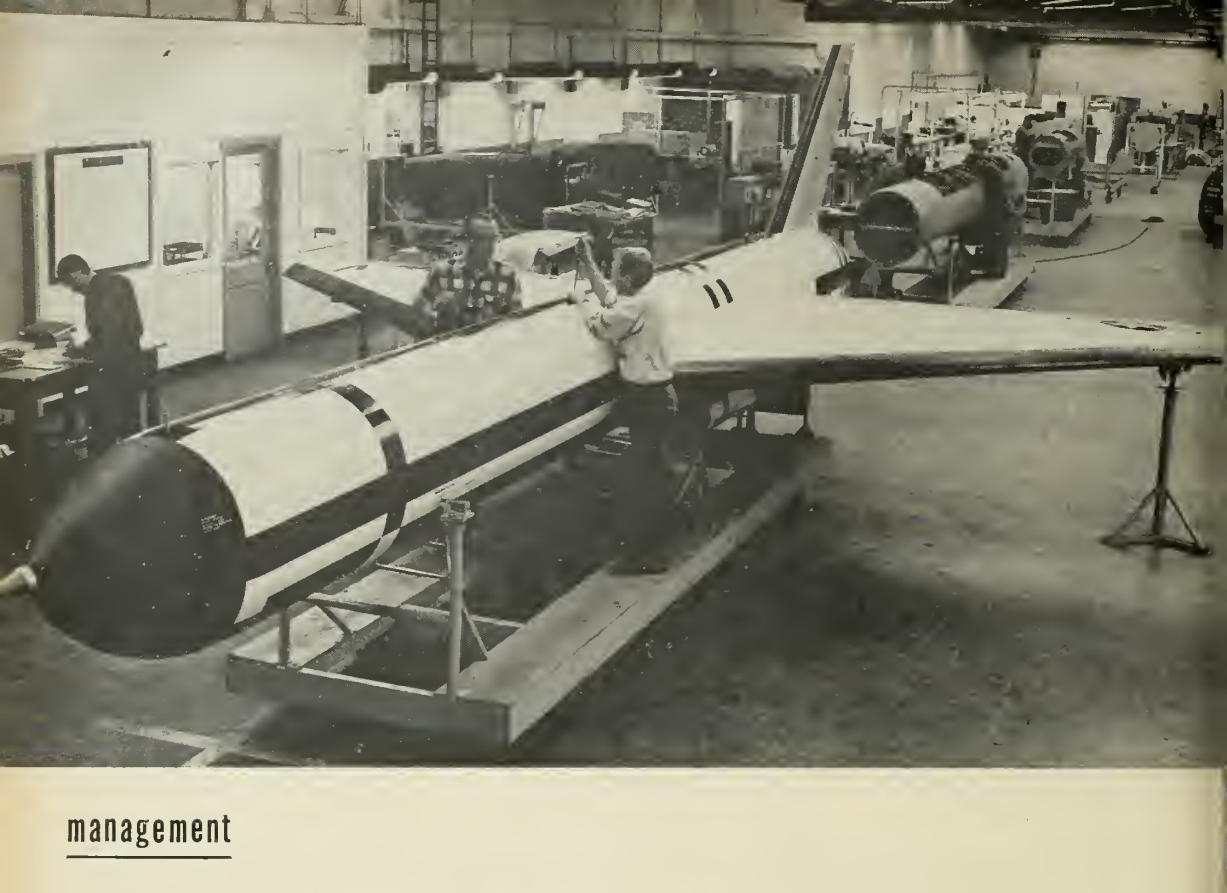
Cleaning Formulas

The cleaning organic-solvent concentrate is emulsified with an equal volume of water to give the following formulation:

44.5 vol-%	140 °F-flash-point aliphatic solvent
5.0 vol-%	diesel fuel
0.5 vol-%	polyethyleneglycol 400 monooleate S1006 (supplied by Glyco Products Co.)
50.0 vol-%	water.

The water-displacing composition currently in use for salvaging equipment is formulated as follows:

93.75 vol-%	1-butanol
0.25 vol-%	2,6 - dy - tertiarybutyl, 4-methyl - phenol
6.00 vol-%	rust-inhibitor concentrate composed of 3.0 vol-% basic barium dinonylnaphthalene sulfonate and 3.0 vol-% naptha diluent to render the rust inhibitor more easily dispersed in the 1-butanol.



management

Fairchild's Future: Bidding for Bi

Reorganized and renamed for Missile/Space endeavor, the veteran firm will expand its successful drone work, step up R&D, sell more F-27's

by James Baar

HAGERSTOWN, MD.—Fairchild Stratos Corp., armed with new leadership and a new name, is now driving forward in an attempt to convert itself from a sick aircraft company to a robust member of the Missile/Space Industry.

The company is engaged in a carefully planned, three-pronged campaign of recovery:

—The expansion into new areas of its work on drone development, based primarily on the successful *SD-5* program.

—The expansion of its R&D capabilities in a number of key areas. This involves both the encouragement of in-house talent and the hiring of new talent.

—An intensified effort to sell its F-27 airplane to both military and civilian buyers.

The first two parts of this campaign are aimed at the new corporate goals toward which Fairchild is now moving. The F-27 sales drive is clearly directed at making the most of the past.

In its essence, the story of this campaign is the story of a corporation's bold fight for survival in the Missile/Space Age. The man at the center of this fight is Fairchilds' new, young president, Edward G. Uhl.

Uhl, the 43-year-old vice president and general manager of Ryan Aeronautical's San Diego Division and formerly vice president and general manager of the Martin Company's Orlando Division, was elected president of Fairchild last February. The election followed a complete shakeup of Fairchild's top management.

In 1960, expected sales of F-27's and new business in sufficient quantity failed to materialize. Gross sales slid $114 million in 1959 to $85 million—half of the sales in 1953. The year 1960 was the third straight year of decline for Fairchild; the fourth straight year barren of stock dividends.

The company was a long way from its heyday during World War II: A long way from the production of the famed PT-19 primary trainer, the big C-82 and C-119 "Flying Boxcars."

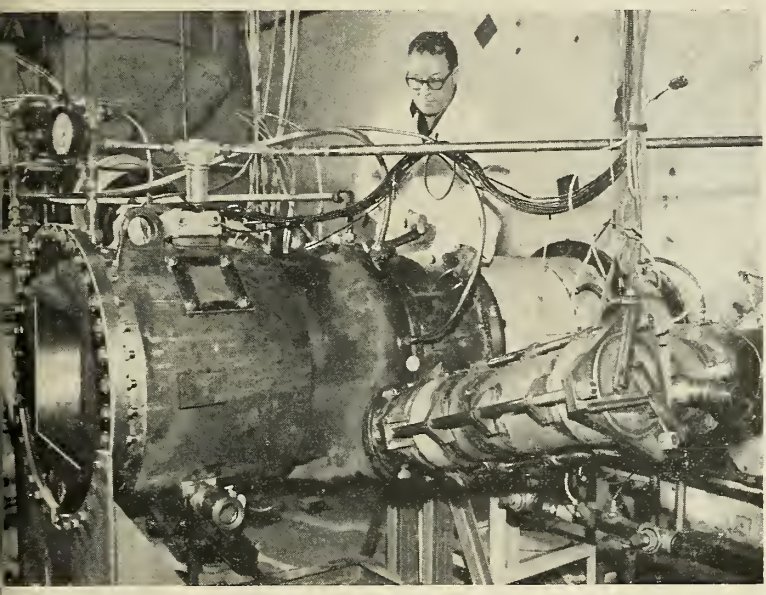
• **Overhauling**—Last October the expected shakeup came. Sherman M. Fairchild, chairman of the board, assumed the job of acting president. J. H. Carmichael, president until then, resigned. Within a short time, almost all



UHL: "We'll get the people we want . . ."

LEFT: *Assembly line for Army's SD-5 reconnaissance drone, which provides biggest Fairchild contract so far.*

BELOW: *Closed-cycle Turbo-Compressor unit for Portable Nuclear Power Plant prepared for test run at Stratos Div.*



lissile/Space R&D Jobs

f the company's other top executive fficers also resigned or were dismissed.

The board chairman then cut operting losses, sold off several properties nd—as his report later put it—"retaffed top management with executive riented by experience in those fields vhere business could reasonably be xpected."

J. T. Dresher, vice president-finance t Hiller Aircraft Corp., became Fairhild's new vice president-finance.



DRESHER (LEFT) AND GRABBER.

John L. Grabber, director of contracts and counsel at Martin/Orlando, became Fairchild's new secretary and director of contracts.

Both Dresher and Grabber are young, highly energetic executives, typical of the sort of organization Fairchild is trying to become. Without question the most typical of this kind of executive is Uhl.

• **'Secret weapon'**—Fairchild's new president was graduated Phi Beta Kappa from Lehigh University. He majored in engineering and physics. During World War II, he served with Army Ordnance and rose from second lieutenant to lieutenant colonel before the defeat of Japan. In 1946 he joined the Martin Company as a research engineer.

Within 10 years, Uhl had become a vice president and established the Orlando Division of Martin. When he left Martin in 1959 to become vice president for technical administration at Ryan, Orlando had 6700 employes and a $175-million backlog of orders. A standing joke at Orlando was that among the division's secret weapons were the *Bullpup* and the Uhlpup.

Uhl sees an important distinction between the problems he faced at Orlando and the ones he is facing at Fairchild.

"When I went down to Orlando, we were trying to form a new beachhead," he said recently, sitting in his office at Fairchild's big Hagerstown plant. "We brought with us three programs: *Bullpup, Lacrosse* and Missile Master. We brought with us roughly 1000 people, about 300 of them engineers. We built from this.

"Here it is different. There is a lot of corrective action needed. The beachhead already has been formed. We have to straighten it out and build from that. And that's the challenge."

• **Hustlers invited**—Uhl sat casually in his shirtsleeves smoking a cigar. His crew haircut and frank, informal tones added to the easy-going impression that he gives. But that is only the surface picture. From behind it one can almost hear the sound of finely-tooled machinery clicking.

"I've been in business 20 years," Uhl said. "I've always had an impression of Fairchild which wasn't a very good one. Fairchild produced things and did it well. But, in general, the company was weak engineering-wise. My analysis is that this is the thing that has led to the company's near-demise. You just can't keep prospering on the work of other people."

Uhl paused and shook his head over the idea of producing what others create.

"We are going to build a sound technical capability at Fairchild in important, selected areas. We already have some top technical people in the organization who have never been encouraged. We will encourage and support them. We are going to bring in top technical people. These are the people around whom we will build our capability.

"I feel certain that we can get the people, the creative people, we are looking for. We will be offering two important things: the right kind of environment and an aggressive management. There are many people of the kind we want who are frustrated now in other organizations when they look up at the crusted layers above them. We are ready to build around this type of man."

Uhl smiled.

"We'll get the people we want when the word gets around that, if you really have an idea and a little hustle in your tail, go to Fairchild."

• **Beef-up by division**—Fairchild's new technical capability is being built up at four divisions that were kept in

(Continued on page 41)

Faster Numerical Control Programing

'Autopromt' language system made by IBM with help from United Aircraft is slashing milling time as well

A NEW COMPUTER language has been devised to cut the lead time in programing numerically-controlled machine tools for cutting complex three-dimensional parts.

The development by IBM's Data Processing Division with an assist from United Aircraft Corp. Research Laboratories is expected to bring about a wider use of this type of machine tool—already employed in the missile/space industry for solid motor aft closures and other difficult parts.

IBM's Autopromt (Automatic Programing of Machine Tools) allows the user to describe the surfaces of the three-dimensional shape to be milled rather than making him specify each path the tool must follow—a procedure which sometimes has meant compromises in tolerances which even extended to the design of the part.

Autopromt, moreover, is designed to make numerical control feasible in limited run production of such items as development models and in complex dies or matrices.

• **Operational procedure** — Autopromt is programed by a series of English-like statements written by an engineer working from a drawing.

He describes each of the constituent surfaces of the shape to be machined, defines the relationships of these surfaces to each other and specifies the machining requirements such as tolerances and tool size. This source program is punched into cards and fed into a computer.

The Autopromt processor program is also fed into the computer for storage in its core memory. This series of more than 30,000 instructions enables the computer to generate automatically from the source program the tool paths necessary to operate the numerically-controlled machine tool.

Under control of the processor program, the computer translates the Autopromt language into suitable computer codes, simulates within itself the surfaces and boundaries to be milled and then calculates the detailed tool travel instructions for each machining region.

The computer then edits these tool travel instructions according to the special requirements of the numerical control equipment being used. This editing is performed by an auxiliary program also stored in the computer's memory. Post-processing is not an integral part of Autopromt because it takes into consideration features peculiar to a particular machine such as chip-removal mechanisms or multiple tool heads.

Characteristics such as overshoot and rate of turning a corner are also handled by the post-processor. Autopromt is written for compatibility with various types of post-processors.

The final output from the computer, the "object program," contains a complete set of numerical instructions to the machine tool. It is on magnetic tape but can be converted to perforated tape of punched cards if necessary.

The original object program can be retained on magnetic tape as a master which can be reproduced as needed for machining at one or more locations. Autopromt instructions can be utilized by any combination of numerical control devices and milling machines. Autopromt is written for IBM 704, 709 and 7090 computers.

Autopromt language consists of 110 English words such as *cone, cylinder, hyperbolic paraboloid, etc.* denoting shapes and surfaces. Words designating surface relationships such as *angle, axis point, intersection of, etc.* are also included. The English-like language is easier to read and write when a program must be checked or studied.

• **Grinding gearboxes**—The first firm to put the Autopromt into use also cooperated in its development. United Aircraft produced a gearbox cover for the S-64 helicopter developed by the Sikorsky Aircraft division.

In conventional milling, it took a machine operator working directly from blueprints about three months to produce the gearbox cover. Using Autopromt on an experimental basis, lead time was reduced to about four weeks, with one week devoted to writing the input for the program and three weeks for running the program on the computer and correcting errors.

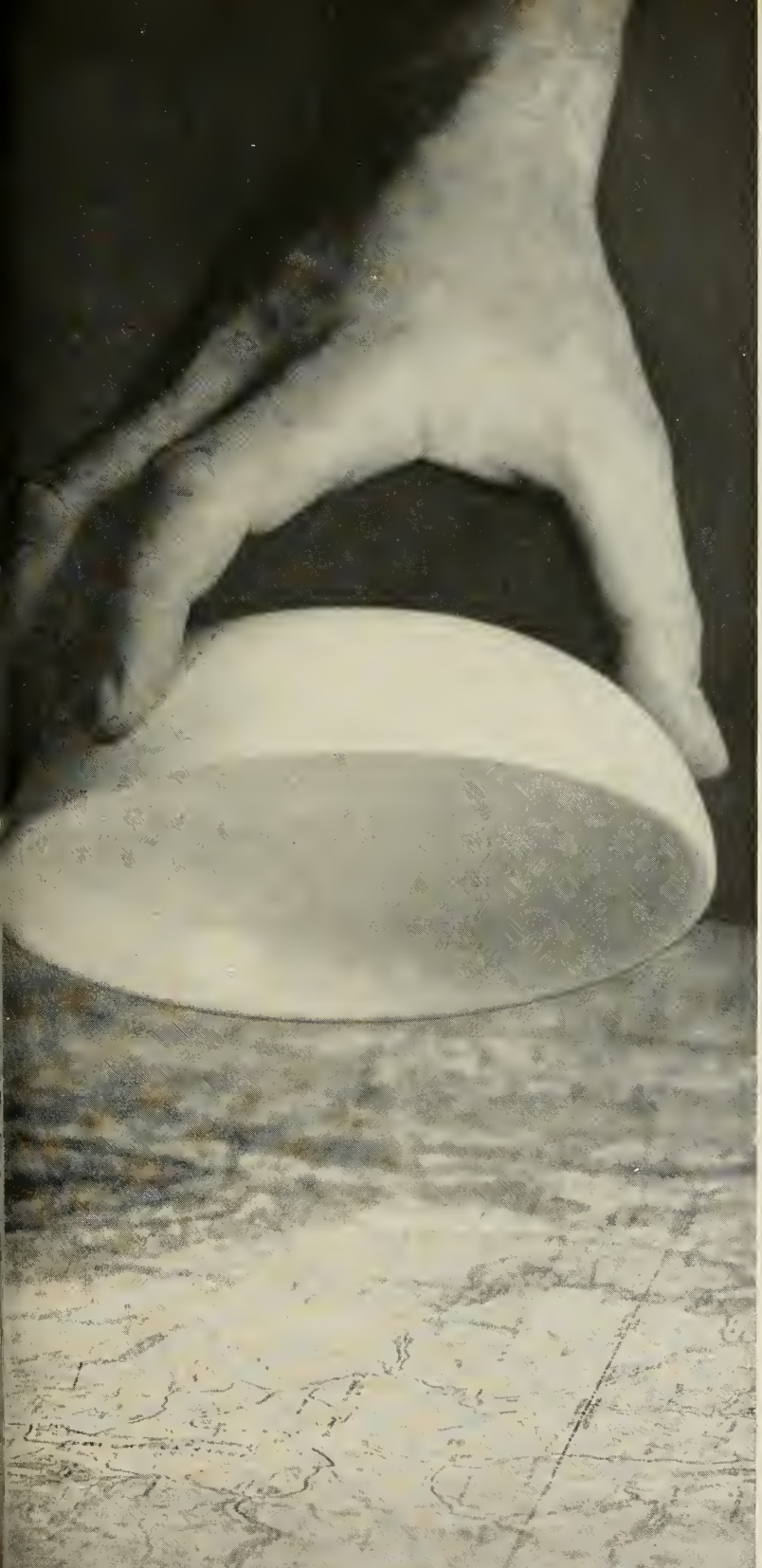
In normal operation, the lead time is expected to be only two weeks for a part of similar complexity.

Actual milling of each part required approximately 150 hours conventionally. This was cut to 40 hours using a numerically-controlled machine tool and Autopromt.

The machine tool used was a Pratt & Whitney Numeric-Keller equipped with an air-cooled Bendix Numerical Control System of modular plug-in construction. ¤



GEARBOX COVER is cut by numerically controlled P & W Keller under instructions from IBM's Autopromt, which automatically generates paths the tool must follow.



He built the strongest roof in the world

This AMF engineer knows what it takes to shrug off megaton forces. He *had* to know because he designed the prototype atomic bomb shelter at Frenchman Flats, the only building that stood up under the force of the atomic bombs exploded there. Well, not altogether—a flange on the door *was* bent.

In order to design the shelter, he had to calculate the effect of the explosion on materials and structures. He had to know how the shock was transmitted through the earth's crust and what effect it would have on the shelter—from beneath as well as from above. And, after the dust of calculating had settled, he had the very practical problem of expressing the results in steel and concrete. He did so, successfully.

Single Command Concept

The solution of this first-time-in-history problem is one more example of AMF's resourcefulness.

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ngineering and manufacturing AMF has ingenuity you can use...

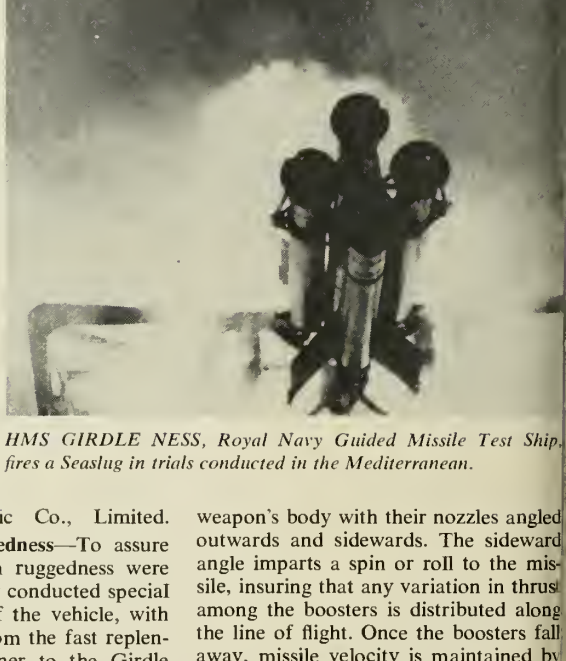
AMERICAN MACHINE & FOUNDRY COMPANY

Circle No. 8 on Subscriber Service Card

Seaslug Success Wins Okay for Mk-2



SEASLUG READY for launching from the quarterdeck of the HMS Devonshire, one of Britain's guided missile destroyers.



HMS GIRDLE NESS, Royal Navy Guided Missile Test Ship, fires a Seaslug in trials conducted in the Mediterranean.

by Bernard Poirier

THE BRITISH ADMIRALTY has authorized development of a longer-range Mark 2 *Seaslug*—even though *Seaslug Mk 1* will not be operational until next year—thanks to the highly successful trial firings conducted at sea and at the Woomera range in Australia.

The *Seaslug* system is unusual in that the missile undergoes a forced roll during the entire boosting phase and is purposely directed to the fringe area of the radar cone before being gathered by guidance along the center-line beam-riding path.

High scores against *Meteor* drone targets were highlights in recently concluded Mediterranean trials by the Royal Navy's 8580-ton Guided Missile Test Ship Girdle Ness.

The 19.5-ft. medium-range missile will join the shorter-range, low-level *Seacat* as standard armament on County Class guided missile destroyers (M/R, June 5, p. 19). The 5200-ton Hampshire and Devonshire have already been launched, and the Kent and London will enter the water this year.

Developers of the *Seaslug* weapon system are Armstrong Whitworth Aircraft (Hawker Siddeley Group), the Sperry Gyroscope Co., Limited, and the General Electric Co., Limited.

• **Proof of ruggedness**—To assure that specifications on ruggedness were met, the British Navy conducted special sea-going transfers of the vehicle, with boosters mounted, from the fast replenishment vessel Retainer to the Girdle Ness.

(In a tragic Viscount air accident over Rome in October, 1958, a *Seaslug* electronic unit fell 30,000 ft. After recovery, all functions but one met testing specs, despite bending and distortion of the package.)

The missile's guidance receiver contains about 100 electronic valves and 800 components. The company says "extensive use is made of printed wiring and individual sub-units are potted in resin." It adds that components recovered from vehicles fired at the Woomera range are often reused in subsequent tests.

The *Seaslug* will be mounted on the afterdeck. The *Seacat* will be located aft on the main deck, but not as far back as the *Seaslug's* radar dish.

• **Spin spreads variation**—The *Seaslug's* flight is divided into five phases—boost; roll-stabilization; gathering; guidance; and interception.

Four solid boosters lie close to the weapon's body with their nozzles angled outwards and sidewards. The sideward angle imparts a spin or roll to the missile, insuring that any variation in thrust among the boosters is distributed along the line of flight. Once the boosters fall away, missile velocity is maintained by a solid sustainer motor.

Before directional control can be applied the rolling motion must be stopped and the missile oriented correctly with respect to the beam. Deflection of all four control surfaces halts the motion; one pair of vertical fins stabilizes it for alignment by means of a free gyroscope reading.

At this point the missile is above the beam and on the fringe of the radar transmitting cone. High *Seaslug* response is required for "gathering" it on to the center beam, where the response of the control system is reduced.

From this point to final interception it remains aligned with the beam, allowing for corrections due to air turbulence. From before launch to detonation the radar commands the system. It locks on a target as soon as it is possible to be designated, and tracks it into missile range. Once the missile is fired, guidance and radar are mated through to the kill.

Microdot Inc. Adds Projects and Products

Owen Lab. Products Added. Strain gage power supplies and control equipment produced by Owen Laboratories have been acquired by Microdot. The acquisition furthers Microdot's expansion in the instrumentation field, and provides strain gage conditioning equipment compatible with other existing Microdot products.

Power Oscillator Offered. As a result of its acquisition of Spectralab Instrument Company, Microdot is offering a line of power oscillators for laboratory use in the evaluation of power measuring devices, driving amplifiers, and other applications where higher power ratings are required.



Model 410 oscillator, shown above, offers a frequency range of 500 to 1050 mcs direct reading. Power range is 50 mv to 50 w. The unit measures 8″ x 11½″ x 19″ and weighs 45 pounds.

Martin Awards Contracts. Assignments for the development of precision temperature measuring systems for the advanced version of the Titan II missile have been awarded to Microdot by the Martin Company, Denver, Colorado. Solid state designs of sophisticated telemetry equipment for extreme environments will be utilized. The systems will be designed, tested, and produced in Microdot's San Diego Division.

MICRODOT INC.

220 Pasadena Avenue
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No man in his right mind would start another war

Granted. Everybody knows it.
Only one trouble. Not everyone is
always in his right mind.

Remember?

That's why those of us in the defense
business should, from time to time, stop
to take stock of what we are really doing...
keeping fingers off buttons.
Because the real
business of the defense business
is survival.

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20% are new faces . . .

DOD Lists 100 Top Primes for 1960

MISSILE/SPACE contractors dominate the Department of Defense roster of the 100 top military prime contractors for calendar 1960.

In computing the totals, only government contracts of $10,000 or more are taken into account.

Twenty firms on the '60 list were not on in '59, and two of the firms included were formed by merger or acquisition of companies appearing in '59. Textron, Inc. bought the defense business of Bell Aircraft Corp., and Ling-Temco Electronics, Inc., bought and merged Temco Aircraft Corp.

Companies	Millians of Dollars
1. Generol Dynamics	$1,294.7
2. Lockheed Aircraft Corp.	1,124.3
3. North American Aviotion, Inc.	964.1
4. General Electric Co.	944.7
5. Boeing Airplane Ca.	867.1
6. United Aircraft Carp.	739.1
7. Martin Co. (The)	708.4
8. Americon Telephone & Telegraph Co.	501.9
9. Hughes Aircraft Ca.	437.6
10. Raytheon Co.	374.2
11. Radia Carp. af America	364.8
12. Douglas Aircraft Co.	353.5
13. Grumman Aircroft Engineering Corp.	336.6
14. Republic Aviatian Carp.	323.3
15. Sperry-Rand Corp.	318.0
16. Internationol Business Machines Corp.	312.1
17. Newport News Shipbuilding & Dry Dock Ca.	302.4
18. Bendix Corp.	274.3
19. Westinghouse Electric Carp.	269.5
20. General Tire & Rubber Co.	257.8
21. General Motors Carp.	214.0
22. Chrysler Corp.	199.5
23. Avco Corp.	193.2
24. International Telephane & Telegraph Carp.	188.3
25. Standard Oil Co. (New Jersey)	163.7
26. Narthrop Carp.	158.0
27. Thiokol Chemical Corp.	140.1
28. Burroughs Corp.	122.7
29. Chance Vought Corp.	120.6
30. Hercules Powder Co.	118.8
31. McDannell Aircraft Carp.	118.8
32. Pan American World Airways, Inc.	109.1
33. Philco Carp.	101.4
34. Thompson Rama Wooldridge, Inc.	100.9
35. Collins Radio Co.	99.0
36. Standard Oil Co. of Califonia	96.9
37. Minneapalis-Honeywell Regulator Ca.	84.3
38. American Machine & Faundry Ca.	83.9
39. General Precision Equipment Corp.	83.0
40. American Basch Armo Corp.	82.4
41. Massachusetts Institute af technolagy	80.9
42. Garrett Corp.	80.8
43. Textron, Inc.	78.1
44. Ling-Temco Electronics, Inc.	$76.9
45. Kaiser-Raymand, Macca-Puget Sound	75.4
46. Texaco, Inc.	74.3
47. Curtiss-Wright Carp.	67.1
48. Goadyear Tire & Rubber Ca.	64.3
49. Food Machinery & Chemicol Carp.	62.6
50. Continental Motors Carp.	62.4
51. Ryan Aeranauticol Ca.	56.2
52. Du Pant (E.I.) de Nemours & Ca.	55.4
53. Olin Mathiesan Chemicol Corp.	53.4
54. Kiewit (Peter) Sons' Ca.	52.7
55. General Telephone & Electranics Corp.	52.6
56. Shell Caribbean Petraleum Ca.	51.7
57. Merritt-Chapmon & Scott Corp.	49.2
58. Laboratary far Electronics	48.9
59. Sacony Mobil Oil Co., Inc.	47.1
60. Marquardt Corp.	46.3
61. Bethlehem Steel Carp.	45.3
62. Lear, Inc.	43.7
63. Magnavox Co.	43.5
64. Northern Pump Ca.	43.1
65. Mason & Hanger-Silas Masan Ca., Inc.	42.6
66. Sanders Associates, Inc.	41.9
67. Todd Shipyards Carp.	40.0
68. Matorola, Inc.	38.0
69. Kaman Aircroft Carp.	36.5
70. Fard Motor Ca.	36.2
71. Ingalls Iran Warks Co.	$ 3
72. Richfield Oil Corp.	34.
73. System Development Corp.	32.
74. Union Carbide Carp.	32.
75. Universal American Corp.	31.
76. Foirchild Engine & Airplane Carp.	30.
77. Continental Oil Ca. (Delaware)	29.
78. Goodrich (B. F.) Ca.	29.
79. Standard Oil Co. (Indiana)	29.
80. Gulf Oil Corp.	29.
81. Firestane Tire & Rubber Ca.	29.
82. Internationol Harvester Ca.	29.
83. Vitro Carp. of America	28.
84. Gilfillan Brothers, Inc.	28.
85. Cook Electric Co.	28.
86. Air Products, Inc.	27.
87. Sinclair Oil Corp.	27.
88. Jones-Teer-Winkelman	27.
89. Johns Hopkins University	27.
90. Utah-Manhattan-Sundt	27
91. Littan Industries, Inc.	27.
92. Hallicrafters Co.	26.
93. Cities Service Ca.	26.
94. Morrison-Knudsen Co.	26.
95. States Marine Carp.	26
96. A R O, Inc.	25.
97. Hazeltine Corp.	25.
98. Union Oil Ca. af California	24
99. Western Contracting Corp.	24.
100. Sunroy Mid-Continent Oil Co.	24.



An Opposite and Equal Reaction

ANCHOR NEEDED—Problems of using tools in weightless, frictionless state ar vividly illustrated in this time-sequence photo taken in a North American Aviation Spac and Information Systems Division study. Compressed air forms layer between stool an platform, creating frictionless state. Man sends himself spinning away when he tries t perform simple repair.

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The Information Processing Center at Lockheed Missiles and Space Division is located in Sunnyvale, California, on the San Francisco Peninsula. Essential to Lockheed Missiles and Space programs is the mechanism necessary to provide sophisticated and efficient test data processing and analysis, scientific computing, and administrative information processing. The Center is one of the largest and most advanced information analysis and computer facilities in the country. Equipment includes three IBM 7090's, three Control Data Corp. 1604's, and a variety of advanced peripheral equipment including a number of IBM 1401 Data Processors.

See reverse side for available positions

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ANALOG COMPUTING

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Provide consulting services to other organizations and perform mathematical analysis in the solution of applicable problems.

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Integration of programming and operating systems, digital computers and related equipment, operational data, training, and publication within the Computation Center.

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Analysis, programming, and programming systems to monitor, control and analyze space vehicles.

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y & State_____ Phone_____

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No. Years Position or type of work

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City & State_____ Phone_____

airchild . . .

(Continued from page 31)

e reorganization: The Aircraft and lissiles Division at Hagerstown; Elec-onics Systems Division (formerly strionics) at Wyandanch, N.Y.; ratos Division at Bay Shore, N.Y.; ıd Aircraft Service Division at St. ugustine, Fla.

The Aircraft and Missiles Division as hit hardest in recent years by the ecline in Fairchild's aircraft manufac-ring. Employment at the Hagerstown ant fell in a few years from 8000-to-),000 down to about 2000. The ant's biggest jobs today are assembling -27's, *SD-5's,* wing parts for B-52 jet ombers and large radar antennas. ompany plans call for early future ex-ansion to take place here.

Most of the work on the *SD-5* one takes place at the Electronics stems Division. Other contracts in-ude "polarized" antenna work for the ir Force.

The Stratos Division is currently e heart of much of Fairchild's techno-gical capability. It is providing ground ipport equipment for a number of mis-les including *Mauler* and *Skybolt* and rborne equipment for *Titan, Atlas* and *Vace.* Stratos' Western Branch plant Manhattan Beach, Calif., is noted r proprietary ASW equipment.

Only last week, Stratos announced the rchase of Tribo-Netics Laboratories, Vermilion, Ohio, a specialist in gas-bricated bearings.

The changing of the corporation's me last month from Fairchild Engine d Airplane Corp. to Fairchild Stratos clearly much more in line with the pabilities of the four divisions and e corporation's new goals. The name irchild was retained to represent ex-rience in the aviation industry dating ck to the years just after World War Stratos represents the future.

• **Selective kissing** — Fairchild's ans to build up its technical organiza-ons are the basis of its hopes to expand share of the missile/space R&D arket.

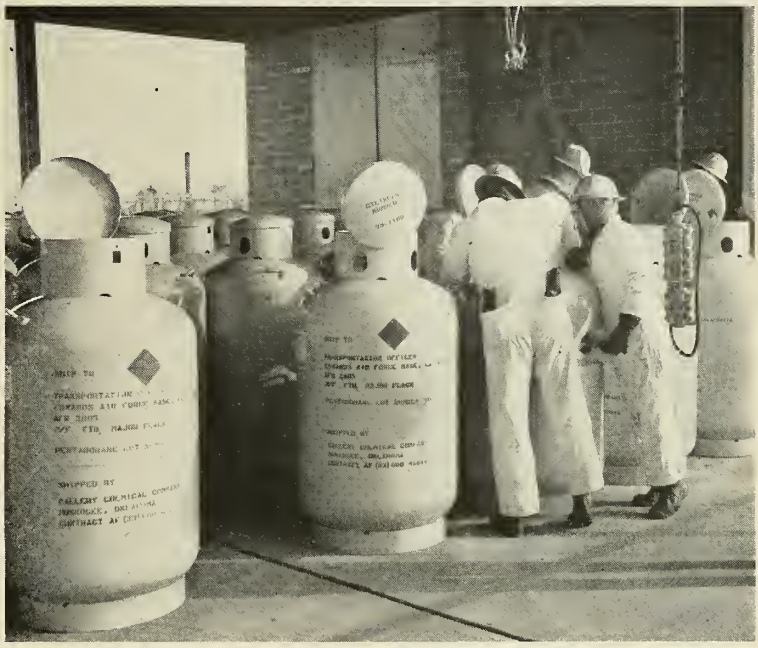
"We see our future in taking prime &D contracts in the missile/space ld," Uhl stated flatly. "I hear many mplaints, but I don't see any reason hy you shouldn't make a good profit ing R&D work. If the people who mplain think it is such a lousy busi-ss, why don't they get out? I think it good. I want to get in.

"It's a matter of making the right oices. I think you have to be very lective. You can kiss all the girls in is business."

"The cream is off the big missile

(Continued on page 43)

GALLERY PROPELLANT BRIEFS



Workmen check bulk containers of pentaborane before shipment to Air Force from Callery's Muskogee, Okla., plant.

Worker Training and Sound Engineering make TONNAGE PENTABORANE AVAILABLE NOW

Pentaborane, like most of the other highly reactive chemicals in propulsion systems, takes respectful handling by properly supervised and trained workers. Callery has been able to bring the tremendous potential of the boranes to the propulsion foreground through the use of sound design and construction principles. We are shipping tonnage quantities of pentaborane from Muskogee under an Air Force contract.

The Callery-developed high temperature data in the next column may provide you with some new directions in your propellant systems design. Other data on pentaborane is available covering density, dielectric constant, heat capacity, solubility, surface tension, vapor pressure and viscosity vs. temperature. Write us for specific details on data and handling procedures for pentaborane.

DENSITY OF LIQUID B_5H_9 vs TEMPERATURE

Temp. (°C)	Observed Density (g/ml)
60	0.5866
70	0.5780
75	0.5741
80	0.5688
90	0.5604
95	0.5561
100	0.5522
110	0.5431
115	0.5389

SOLUBILITY OF NITROGEN IN LIQUID B_5H_9

(Total Pressure 1000 ± 7 psig)

Temp. (°C)	Solubility		
	IGPP(1)	MR(2)	H(3)
30	68.7	0.0559	8.14×10^{-4}
50	68.4	0.0607	8.87
70	67.9	0.0644	9.48
100	65.9	0.0711	10.79
129	62.8	0.0722	11.50
150	59.6	0.0779	13.07

(1) IGPP, Ideal Gas Partial Pressure (atm. Abs)
(2) MR is moles gas/ mole pentaborane
(3) H is MR/IGPP

Callery Chemical Company, Defense Products Department

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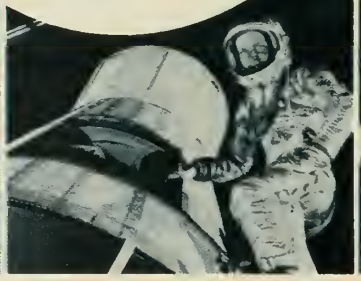
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ottle," he said. "The missile programs
) come will be the tactical ones. I
on't see why we shouldn't take a crack
t them. Also someone is going to re-
lace someday missiles that we have
ke the *Bullpup*.

"Fairchild already has a very good
issile in the *SD-5* drone. It could
e a work horse. It could be made to
arry cargo. It could be a tactical
issile. Our first new series of proposals
volve expanding our drone capability.

"Antennas are another area where
e already are at work. And there are
thers. I was pleasantly surprised to
nd what technical capability Fairchild
lready has. At the Stratos Division,
or instance, there are good environ-
ental test facilities, and electronic
acilities."

• **Selling F-27**—As for the F-27, Uhl expressed new confidence in selling he plane to the military services.

"The F-27 can do a lot of very im-ortant jobs. This expansion of limited ar forces makes the need for aircraft f this type even greater. Take a ountry like Laos. The DC-3 is the only ay to provide support. But the DC-3's re getting older and older. And the -27 can do the job—and more."

Uhl's expectation of military sales or the F-27 has yet to be given much redence outside of Fairchild. The mili-ary services have not been enthusiastic. And future sales to airlines will be much nfluenced by the services' decisions.

Meantime, Fairchild has sold nearly 0 F-27's to 13 commercial airlines rom Hawaii to Turkey. It also has sold 9 to private corporations. The plane an operational success, but for various ther reasons it has not been accepted y the Pentagon.

Unquestionably an important one of hese reasons has been some strained elationships with the military services n the past. The improvement of the ompany's relationship with the govern-ent is one of the new management's rimary concerns.

But, whatever the fate of the F-27, ome of Uhl's expectations in other reas already are being proven out.

The Army Signal Corps has awarded airchild a $7.8-million contract for evelopment of a "multi-purpose" ver-ion of the *SD-5*. It will be called the *D-5 (XE-2)*.

To date, the *SD-5* program is Fair-hild's biggest contract. It has totalled bout $60 million since it was started in 957. The new contract was considered highly favorable omen.

As Uhl put it:

"I don't feel ashamed with what we ave technically today at Fairchild. In any areas we already can compete ith the 'bigs.'" ⌗



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:,682,345—Douglas Aircraft Co., Santa Monica, Calif., for support of the MB-1 *Genie* air-to-air rocket.

000,000—McDonnell Aircraft Corp., St. Louis, for research and development to obtain data on re-entry vehicles.

717,936—Sperry Gyroscope Co., Great Neck, N.Y., for maintenance materiel and parts in support of 4 long-rang search radars.

301,957—General Electric Co., New York City, for 9 high-powered, frequency diversity radars.

469,366—Minneapolis-Honeywell, Minneapolis, for development of the primary guidance system for the *Dyna-Soar* test vehicle.

002,922—RCA Electronic Products Div., Camden, N. J., for development work on communications and data link subsystem for the *Dyna-Soar*.

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NAVY

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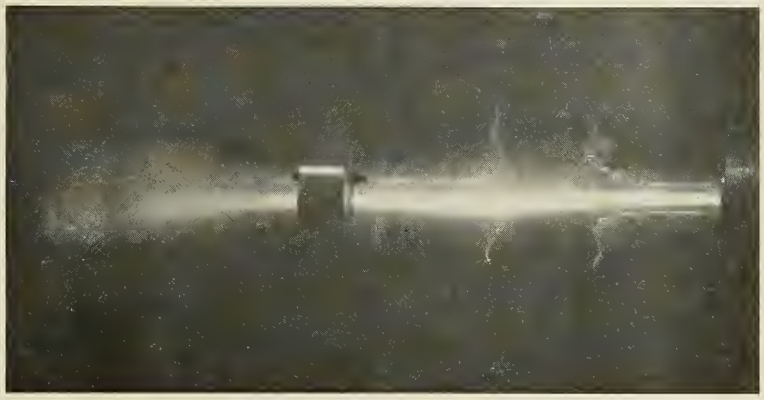
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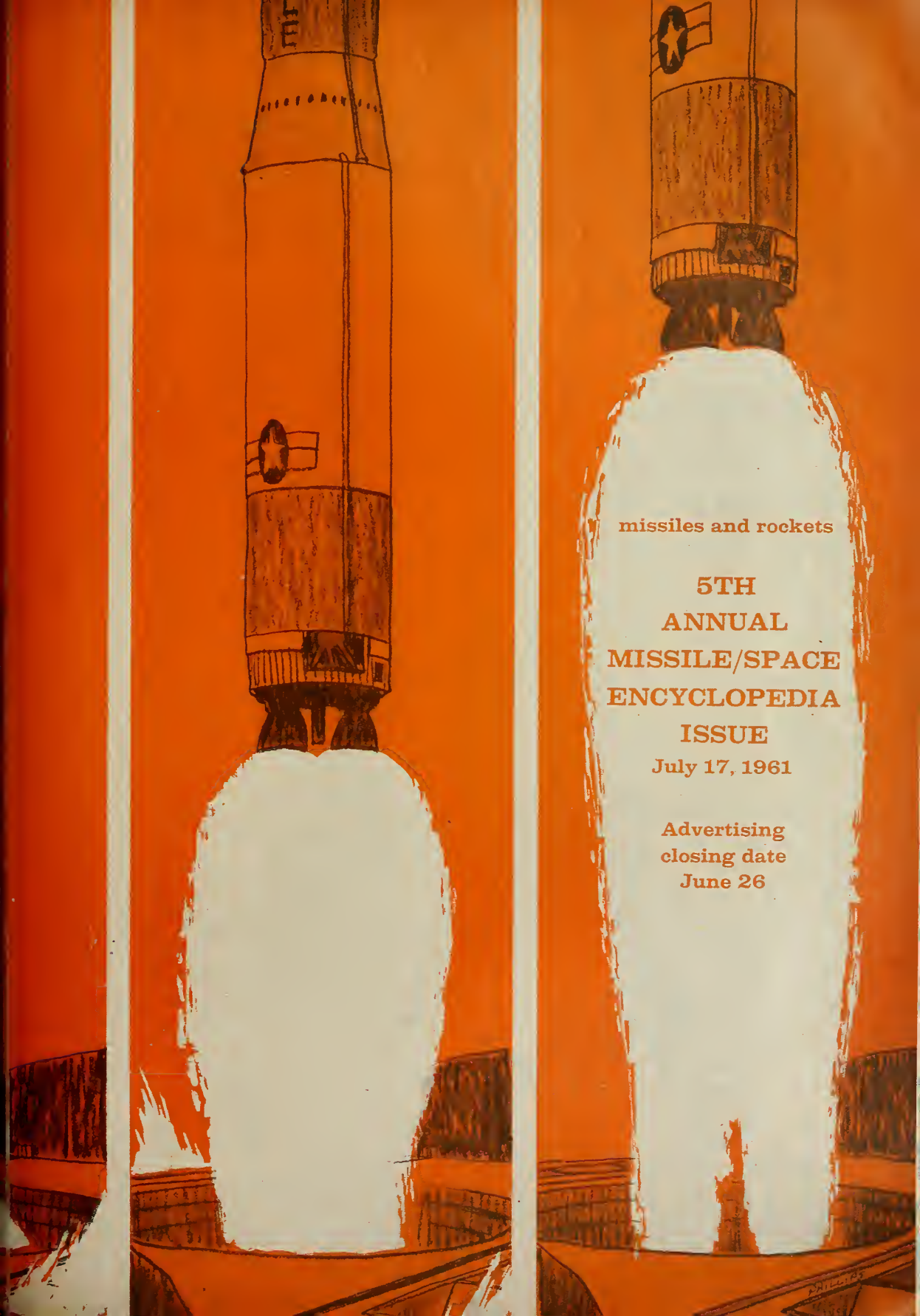
The only single source for a complete and comprehensive analysis of world missile/space systems, M/R's 1961 Missile/Space Encyclopedia will include diagrams and descriptions of all U. S. and foreign missiles and spacecraft.

The 5th annual issue of the Missile/Space Encyclopedia will be distributed to MISSILES AND ROCKETS' 32,500* paid subscribers—plus a bonus circulation of 7,500 for distribution to top military personnel and to U. S. service academies.

With a total distribution of more than 40,000, M/R's July 17 Missile/Space Encyclopedia issue will thus reach virtually all of the people who direct the activities of the missile/space industry, with the most complete coverage-in-depth of key buying and specifying influences.

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missiles and rockets

5TH ANNUAL MISSILE/SPACE ENCYCLOPEDIA ISSUE

July 17, 1961

Advertising closing date June 26



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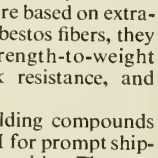
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names in the news



BRENDLE



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Dale V. Ness: Named director, Washington office of The Mitre Corp., succeeding **Bryan F. LaPlante,** named special assistant to the president at the company's headquarters in Bedford, Mass.

Mitre Corp, has formed a new Field Test and Evaluation Department at Montgomery, Ala., and Fort Walton Beach, Fla., to handle field test and evaluation for SAGE and for design and evaluation of similar advanced electronic systems. **Lawrence L. Holmes** will head the new department, with **Earle K. Gates** as associate department head.

Thomas A. Brendle: Appointed manager of electronic development, American Optical Co.'s Instrument Div., Buffalo, N.Y. Prior to joining AO's Instrument Div., Brendle was product manager of nuclear systems, Curtiss-Wright Corp.

E. J. Lancaster: Chief, quality assurance, Ballistic Systems Division, AFSC, Los Angeles, elected a vice president of the American Society for Quality Control. Lancaster also is chairman of the Los Angeles Section of the Society.

William S. Blakeslee: Appointed group executive-Defense for Chrysler Corp., Detroit. Blakeslee, formerly general manager of Defense Operations Div., succeeds **I. J. Minett,** promoted to group executive and chief operating officer of the International Group. Blakeslee will direct the activities of the company's Defense Group, which includes the Defense Operations Div., Missile Div., and Advanced Projects Organization.

Fred M. Heddinger: Former assistant to the general manager, named director of newly-created semiconductor molecular electronics department, Westinghouse Electric Corp., Youngwood, Pa. Other appointments in the department are: **Dr. H. W. Henkels,** engineering manager; **K. G. Cooley,** manufacturing manager; and **Ozzie Jaeger,** sales manager.

Roy J. Benecchi: Appointed vice president and assistant to the president of Lear, Incorporated, Santa Monica, Calif. Benecchi has been with Lear in various management posts since 1941.

Fred Hermann: Special projects engineer at Tenney Engineering, Inc., appointed manager of new West Coast Division based at the Harvick Manufacturing Corp., South Gate, Calif., recently acquired by Tenney. Hermann also has been nam a vice president of Harvick.

Manuel E. Haskins, Jr.: Appoint manager, Management Science, in t Electronic Data Processing Division Radio Corporation of America.

Arthur P. Stern: Appointed director engineering, Electronics Division, T Martin Co., Baltimore. Before joini Martin, Stern was manager of the El tronic Applications Laboratory of the Ge eral Electric Co.

Hugh E. Webber: Named director the Technical and Research Staff, Marti Orlando Division. Webber replaces **Jan G. Houser,** named program manager of t MISSILE MASTER and BIRDiE air fense coordination systems.

Jesse L. Jones: Transferred from Segundo division to Santa Monica di sion of Douglas Aircraft Co., as vi president-general manager. **James W. R** promoted to general manager of the Segundo division, effective August 1.

Donald L. Johnson: Promoted to m ager, Manufacturing Section, General El tric's Defense Systems Dept. With GE years, Johnson previously was manager the Department's Support and Implemen tion Section.

Starr W. Cahill: Elected vice presid of manufacturing, Hycon Mfg. Co., M rovia, Calif. Cahill formerly was direc of engineering operations.

Robert L. Dickson: Elected presid of Walter Kidde & Co., Inc., Bellesvi N. J. **John F. Kidde,** president since 19 will become chairman of the board.

Frank L. Roberts: Appointed vice p ident and assistant to the president Sperry Gyroscope Co., Great Neck, N

Warren P. Turner and **Hans Hans** Appointed executive assistant to the pr dent and chief engineer, respectively, KPT Mfg. Co., Roseland, N.J. Turner been products manager of solid propell and military explosives, Energy Div., C Mathieson Chemical Corp., and special sistant to the vice president and techn director of the High Energy Fuels I Hansen formerly was chief engineer of Engineering Products Division, McK nan Terry Corp.

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Metallurgical Manager—B.S.—M.S., with demonstrated administrative and technical ability. Position involves managing and directing the activities of a modern metallurgical and welding laboratory engaged in both the ferrous and nonferrous fields. This laboratory performs an important function in the operation of a large, integrated facility engaged in both product development and production activities.

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—when and where—

JUNE

Institute of Radio Engineers, 5th Annual Convention on Military Electronics, Shoreham Hotel, Washington, D.C., June 26-28.

British Interplanetary Society, European Symposium on Space Technology, Federation of British Industries, London, June 26-28.

Aerospace Transportation Committee, AIEE, Concepts and Design in Aerospace Electricity, Benjamin Franklin Hotel, Philadelphia, June 26-30.

Rocket Testing in Simulated Space and High Altitude Environments (secret) sponsored by ARO, Inc., Aerospace Corp., USAF, Arnold Center, Tullahoma, Tenn., June 28-29.

Joint Automatic Control Conference, sponsored by AIChE, ISA, ASME, IRE and AIEE, University of Colorado, Boulder, June 28-30.

Institute of Navigation, Annual Meeting, Williamsburg Inn, Williamsburg, Va., June 28-July 1.

National Bureau of Standards, One-day Meeting on High-Precision Connectors. Boulder Laboratories, Boulder, Colo., June 29.

JULY

Western Plant Maintenance and Engineering Show, Pan Pacific Auditorium, Los Angeles, July 18-20.

AFOSR, Differential Equations in Nonlinear mechanics, co-sponsored with Martin's RIAS, Air Force Academy, Colorado Springs, July 31-Aug. 4.

Physics of the Solar System and Re-entry Dynamics, National Science Foundation, NASA, Virginia Polytechnic Institute, Blacksburg, Va., July 31-Aug. 11.

AUGUST

Space Age Astronomy, sponsored by Douglas Aircraft Co., CalTech, Pasadena, Calif., Aug. 7-9.

American Rocket Society, Stanford University, Guidance and Control Conference (some sessions classified), Stanford University, Palo Alto, Calif., Aug. 7-9.

Sixth Annual Technical Symposium, Society of Photographic Instrumentation Engineers, Ambassador Hotel, Los Angeles, Aug. 7-11.

International Astronomical Union, Eleventh General Assembly, Pasadena, Calif., Aug. 15-24.

International Conference on Hypersonics, American Rocket Society, Compton Lecture Hall, Massachusetts Institute of Technology, Cambridge, Aug. 16-18.

Welded Electronic Packaging Association, Symposium, Lockheed Missiles and Space Div.'s Palo Alto research facility, Palo Alto, Calif., Aug. 21.

10th Pacific Science Congress, National Academy of Sciences, University of Hawaii, Honolulu, Aug. 21-Sept. 8.

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editorial . . .

A New Emphasis on Quality

DEFENSE SECRETARY McNAMARA and his staff are taking a close look at some of the procurement practices which have been wasting a sizable portion of this nation's defense expenditure. This is not only to be welcomed, but it is a step which many leaders of the missile/space industry have been urging for some time, particularly in the electronics field.

Loose specifications, poor quality control, overemphasis on initial price with a corresponding lack of attention to long-life performance, have concerned responsible firms to an increasing degree of late.

There has been a singular lack of reward for the company turning out a quality product. Cost-cutting in procurement has been carried to the point where subsequent maintenance and spare parts costs have skyrocketed out of all proportion.

This has left the firm which attempts to do a responsible job in a difficult position. It can either reduce the quality of its products or watch the red ink mount as government contracts go to less conscientious competitors.

While it is comforting to think that quality eventually will tell, this is little solace to a firm already forced out of business.

The blame for this situation usually falls on the Defense Department. But a great many other factors are involved. Emphasis in Congress and the press has been on initial cost of equipment, with correspondingly little emphasis on the over-all amortized costs. Highly vocal critics of the "profiteering" defense industry have forced DOD further and further toward cost reimbursement contracts and away from fixed-price contracts, which are less easy to defend against this charge.

Deputy Secretary Roswell Gilpatric pointed out recently that where 87% of Air Force procurement ten years ago was through fixed-price contracts and less than 13% on a cost reimbursement basis, cost reimbursement contracts today account for almost 43% of procurement.

Cost reimbursement contracts of the cost-plus-fixed-fee type, which make up the present majority, weaken the incentive for economy. Emphasis has been on profit-cutting at the expense of cost-cutting.

Defense Secretary McNamara now has come up with what has been described as a new type of incentive contract. This is called the "cost-plus-award-fee" contract which will penalize poor performance, reward good performance. The approach is not entirely novel, as anyone will realize who looks at the military contract for the first Wright Bros. airplane.

But it certainly places the emphasis where it belongs: on over-all performance and quality and reliability of the product, in comparison with the original military specifications. This type of contract will not be easy to administer in the missile/space industry. But it deserves every chance.

THE REASON is evident. It was put well in a recent speech by W. A. MacDonald, chairman of the board of Hazeltine Corp. He estimates that only 25% of the budget allocation in electronic procurement goes into new weapon systems. Annual maintenance cost of electronic weapon systems inventory is placed at 60% of initial cost.

Yet the emphasis in letting contracts, as Mr. MacDonald suggests, has been on equipment which will meet the minimum requirements at the lowest possible price.

"The adverse ratio of maintenance cost to initial cost either on the basis of yearly or useful life costs seems to me to indicate something basically unsound in our procurement philosophies," Mr. MacDonald says. "We . . . have gone far beyond a safe balance in reducing first or instantaneous costs and are paying a terrible price in maintenance costs."

The Hazeltine chairman estimates that a 50% improvement in failure factor could mean an annual saving of $1.7-billion, or one-third the total electronics budget, on maintenance, support equipment and spare parts costs.

One step toward this is the realization that the true cost of a black box is based, not merely on its initial cost, but on its useful life, including maintenance costs. Another is the incentive contract proposed by DOD.

We welcome DOD's approach and hope it will be coupled with a full recognition of quality and reliability as well as initial cost and on-time delivery. This would encourage those missile/space firms which are making the most worthwhile efforts—and serve notice on those which are not to either toe the mark or get out of the industry.

William J. Coughlin

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For military commanders and governmental leaders this is a new era of decision and control. Many of their decisions and actions must be made with great speed as events occur. They must be based on huge amounts of information. And they affect world-wide and continental forces. To help command groups exercise their powers of decision and control, a new technology has been developed—large-scale systems that involve automated information processing assistance. ■ Acting in the public interest, we have made major contributions to a number of these systems. SAGE was the first. The SAC Control System is in development. And we are beginning work on two other extremely large systems. Our main efforts are in analysis and synthesis of these systems, training men for their use, instructing great computers on which the systems are based—and research into future generations of these systems. ■ In developing these systems we follow a close interdisciplinary approach. Operations Research, Engineering, Computer Programming and Human Factors are the essential disciplines. Our expanding programs have created a number of new positions at our facilities in Santa Monica, Calif., Lexington, Mass., Washington, D.C., and Paramus, N.J. Inquiries are invited from those who wish to contribute to this new technology. ■ All qualified applicants will receive consideration for employment without regard to race, creed, color or national origin. ■ Address Mr. Robert L. Obrey, SDC, 2433 Colorado Ave., Santa Monica, Calif.

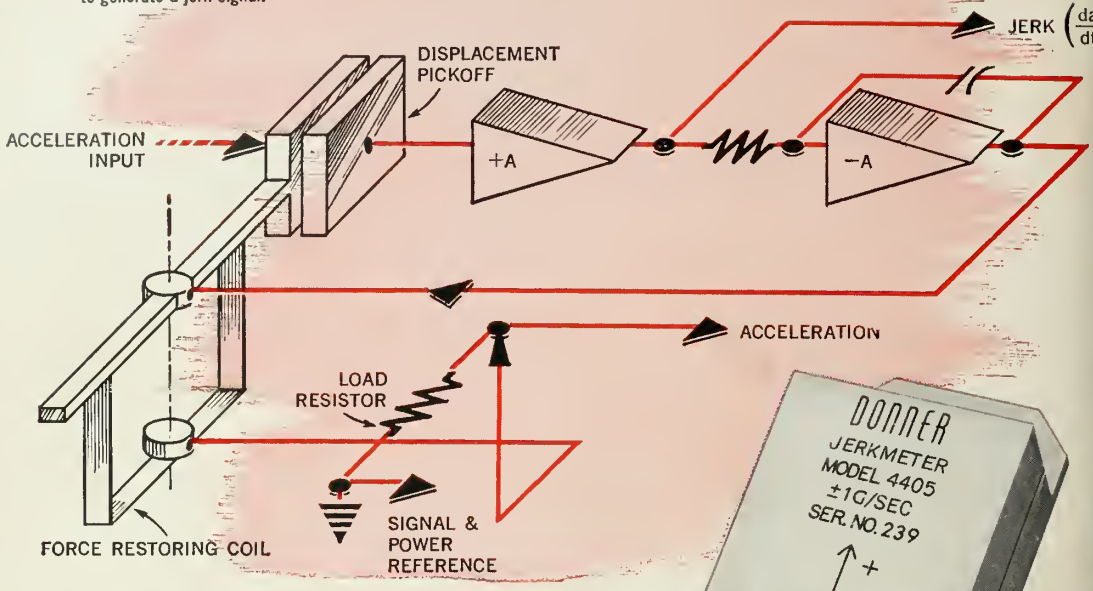
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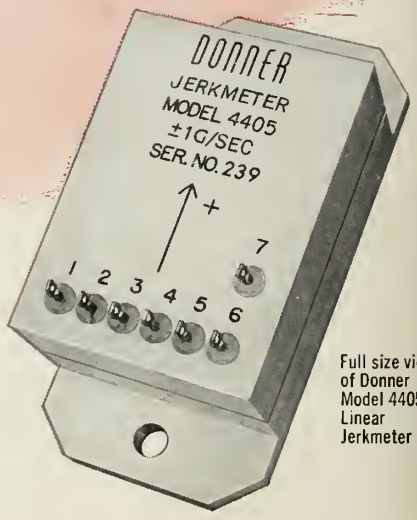
Systems that help men make decisions and exert control



Functional diagram of Donner Linear Jerkmeter. This unique instrument operates as a subminiature servo-system of the force-balance type which is responsive to jerk along the sensitivity axis of the linear unit and about the sensitive axis of the angular unit. Basically, the system consists of a transistorized accelerometer with an integrator inserted into the servo-loop to generate a jerk signal.



HOW TO MEASURE $\frac{da}{dt}$



Full size view of Donner Model 4405 Linear Jerkmeter

New Donner precision Jerkmeters measure linear and angular jerk to ±0.5% or better.

If your measurement and control problem requires accurate measurement of jerk or the rate of change of acceleration, Donner Scientific's new line of precision angular and linear jerkmeters can help.

These new instruments are the only truly accurate device of this type ever made. They are designed to meet the most demanding applications. Both angular and linear jerkmeters provide an output voltage proportional to jerk which in turn can be used to instigate compensatory control forces or other actions. *An acceleration analog output voltage is also available.*

Typically, a jerkmeter installed in a jet aircraft will provide a instantaneous output proportional to the rate of change of g's. This signal can be used to predict impending disaster conditions.

Other applications include use wherever constant acceleration is required. Here, the Donner jerkmeter provides a "velocity damping" term. The jerkmeter also provides a third order term for stabilizing displacement devices. It can also be used as a inertial indicator of first motion.

KEY SPECIFICATIONS for Model 4405 Linear Jerkmeter

RANGES
Acceleration: ±1 g full range to ±30 g full range
Jerk: ±0.5 g/sec full range to ±20 g/sec full range

OUTPUT FULL SCALE
Accelerometer: ±7.5 v dc
Jerk: ±7.5 v dc

RESOLUTION
0.1% full scale or better

LINEARITY
0.1% full scale or better

HYSTERESIS
Less than 0.1%

POWER
+15 v dc at 10 ma and −15v dc at 10 ma

SIZE
3" long, 1½" wide, 1⅝" high

WEIGHT
7.5 ounces

WANT MORE INFORMATION? *The new Donner Jerkmeter is another product from a firm specializing in the manufacture of accurate fixed and general purpose analog systems designed to analyze, measure, and control inputs interlocking time, acceleration, jerk, velocity, and other dynamic inputs. Complete technical information can be obtained by calling your nearby Donner engineering sales representative or writing Dept. 123*

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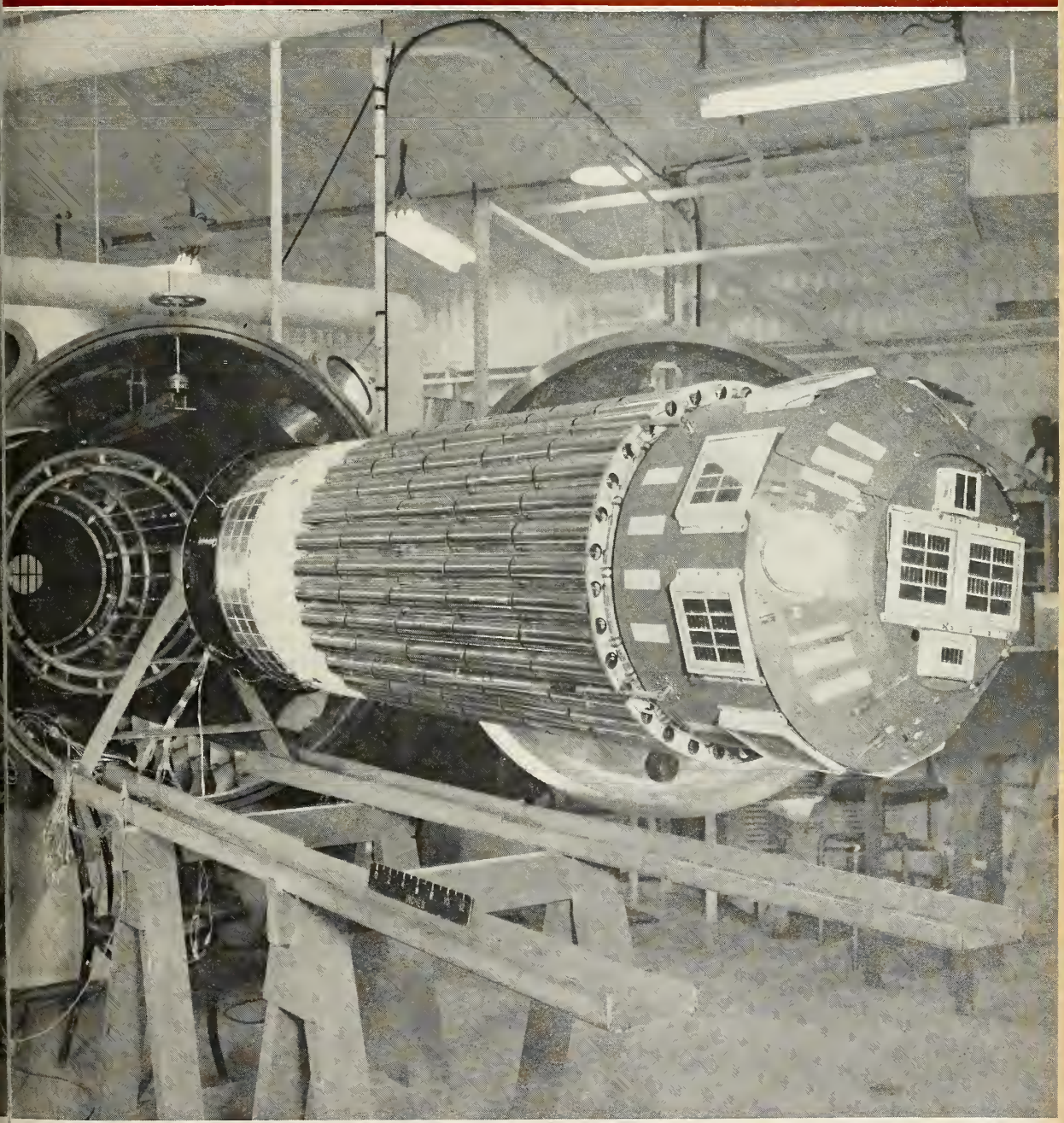
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JULY 3, 1961

missiles and rockets

THE MISSILE/SPACE WEEKLY

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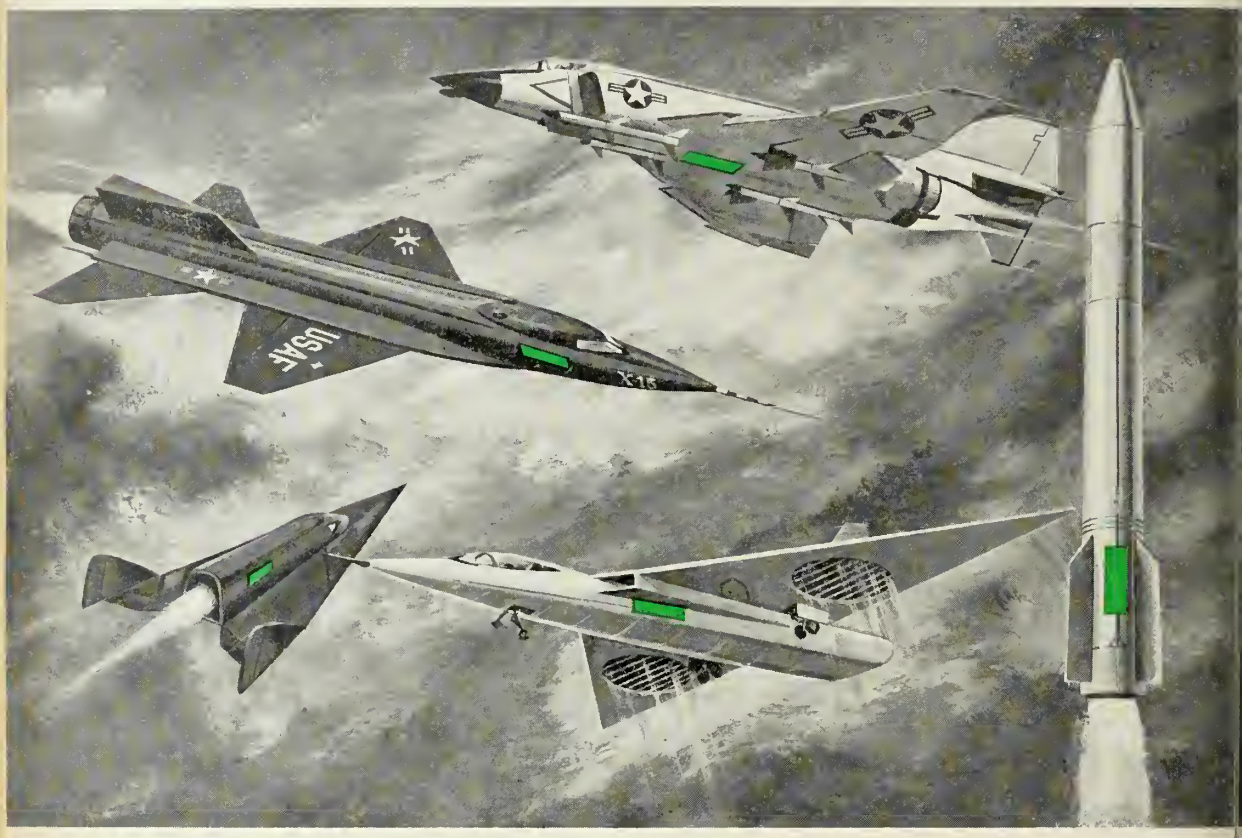
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A whole new flight spectrum of manned and unmanned vehicles is at hand. To meet the unique range of control requirements of these vehicles, General Electric now offers a completely new type of flight control system, called GESAC. (General Electric Self-Adaptive Control.)

A knowledge of the detailed aerodynamic characteristics of a missile or aircraft is not required to apply GESAC to the vehicle. Thus, both flight testing and application engineering effort can be sharply reduced.

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GESAC has already been successfully flight-tested aboard the Convair F-106 under Navy Bureau of Weapons sponsorship. An evaluation of extremely rigorous re-entry profiles has been conducted on the North American/NASA X-15 Simulator under Air Force contract, with outstanding success. A flight evaluation on the McDonnell F4H-1 is currently in progress under Navy BuWeps contract. GESAC provides another example of Light Military Electronics Department leadership in aero/space electronics.

150-03

GENERAL ELECTRIC

Light Military Electronics Department

Armament & Control Section, Johnson City, New York

Circle No. 1 on Subscriber Service Card

Is Defense Advertising Necessary?

There has been a lot of talk lately about the cost of the advertising done by defense contractors. One prominent Senator recently said he was greatly disturbed over heavy defense advertising expenditures. He pegged the cost "to the taxpayer" at $500 million.

This figure is many, many times the actual total of defense advertising expenditures and only a fraction of that total is recoverable. The Senator's facts are wrong; but, even more disturbing, it appears that he doesn't understand the purpose and function of sound advertising. He considers this money down the drain and thinks it should not have been spent.

There are other instances demonstrating a growing wave of anti-advertising sentiment in high government places. They indicate a lack of understanding and represent a threat both to freedom of the press and success of the Nation's defense goals.

We publish specialized business magazines and reference books. Several of these are defense oriented. They perform communications functions essential to our national goals . . . more essential now than ever before because of the complexity of today's technological and political challenges. There are other excellent magazines having the same or similar purposes. We're delighted—because competition is healthy and because there is more to be done than can be handled by any one of us.

Virtually all publications are financed, by and large, by advertising. This is healthy, too; but it is not the primary reason for defense advertising.

We believe that advertising is an effective and necessary tool for the defense contractor. The objectives of defense advertising are many: some of them obvious, others more subtle.

Sales is one obvious objective. It can be demonstrated that advertising, for some defense products, has led directly to sales. In other instances, selling is a long, complex process, where features of current products may not be as important as company reputation. In both cases, the government wants competition for defense contracts—by use of a competitive bidding system, it gets better products for less money. How is a company to compete if it is not allowed the use of sales tools—one of which is advertising?

Recruiting is another obvious objective. Will that engineer who is inspired to contribute to technological advancement in the missile/space age, for example, be interested in learning more about the kind of company he goes to work for? You bet he will, and more power to him.

The dissemination of technical information is a third, and perhaps the most important, objective. The exchange of such information is one of the biggest problems facing both government and industry. And what more effective, more economical means of disseminating necessary technical information exists than the business press? Mills Shepard, who performs readership studies on one of our publications, reports that advertisements are often read as avidly as the editorial pages. And Eastman Research, in a study released May 29, based on more than 100 surveys for 32 business-paper clients over a two-year period, reports that *70% of the readers interviewed read the advertising in these businesspapers on purpose.*

There are many other equally important objectives. Companies must raise capital in order to be able to do the jobs that need doing for defense. Good community and employee relations are considered necessary to a company's well-being. These and other objectives have been effectively achieved by defense contractors through advertising.

The defense industry is made up of numerous private companies facing the tremendous challenge of meeting, in cooperation with the government, our national technological goals. To meet this challenge, the companies must be strong and healthy. To deprive them of the use of effective and honest advertising is shortsighted and wrong.

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KEARFOTT KING SERIES MINIATURE FLOATED RATE INTEGRATING GYROS

Combining the advantages of small size, exceptional reliability and unparalleled performance, the King Series, representing a major improvement in precision floated gyro design, is now in quantity production.

Day-to-day performance of 0.1°/hour without trimming over a 4 month period has been obtained. During these tests, the gyro was maintained at operating temperature only during tests and permitted to cool to room temperature between tests.

Simplified construction yields high reliability while unique design techniques have made possible highest angular moment of any gyro in comparable size.

Two basic gyros constitute the King Series, a gas bearing gyro motor offering long life and low noise characteristics, and a conventional ball bearing permanently lubricated gyro motor.

CHARACTERISTICS

	C70 2590-001 Gas Bearing Spin Motor	C70 2519 001 C70 2523 001 C70 2520 001 C70 2527 001 Ball Bearing Spin Motor
Angular Momentum (gm cm²/sec)	3.5 X 10^5	5 X 10^5
Orift, Vertical (short term) (°/hr.)	0.003	0.003
Orift, Azimuth (short term) (°/hr.)	0.015	0.015
Mass Unbalance (max. each axis) (°/hr.)	0.2	0.2
Fixed Torque (max.) (°/hr.)	0.2	0.2
Mass Unbalance Shift (max. spread) (°/hr.)	0.2	0.2
Fixed Torque Shift (max. spread) (°/hr.)	0.2	0.2
Torquing Rate (max.) (°/hr.)	22,000	22,000
Torquer Linarity (% to 165 °/hr.)	0.01	0.01

FEATURES

C70 2590 001 — Provides high temperature capabilities and minimum operating life of 10,000 hours.

C70 2519 001 — Incorporates heaters and temperature sensors. It is trunnion mounted.

C70 2520 001 — Similar to the unit above, it incorporates switches that close when gyro comes in contact with its stops.

C70 2523 001 — identical to the C70 2519 001 except flange mounted at gyro CG rather than trunnion mounted.

C70 2527 001 — Basicly the C70 2519 001 in an IRIG mechanical configuration.

Write for complete data

KEARFOTT DIVISION
GENERAL PRECISION, INC.

Little Falls, New Jersey

—letters—

Stockholder Protests

To the Editor:

As an A.T.&T. Company employe and stockholder, I feel that your June 1 editorial ("Let's Temper Urgency wit Caution") is biased in favor of the sc called "missile/space" firms, which is, c course, understandable. However, I woul like to express my views . . .

First, I don't agree that the FCC belief that the venture (space communic tions) be turned over to the internation common carriers is a "decision in ac vance." To my way of thinking it is onl logical that satellite communications b handled by those with the experience an proven capabilities of the communicatior industry, because satellite communication to be of the greatest value to the publi must supplement and improve existing sy tems. Therefore it seems to me that th FCC is being more than fair when it cor siders objections to this logical step.

Secondly, as far as the anti-trust law are concerned, I personally don't unde stand why those companies engaged in th production and sale of communicatio equipment should necessarily be involve in the ultimate use made of their equi ment. If this held true for communicatior as we now know it, the telephone systen would be involved in such a muddle ownership mixup that our progress woul be nowhere near its present high stat Take the case of the underseas cable Should the shipbuilding industry be i volved in the cable ownership just becau a ship was used to lay it? And how abo the cable manufacturer? Does he rate slice of the ownership? I think not. Con munication facilities are owned by tho who provide communication services.

Third, your statement that technic merits of the various satellite systems pr posed should be studied is ridiculous. Th A.T.&T. Co. and its partners, both dome tic and foreign, are prepared to finance satellite communications system NOV Developments are far along in the pr gram to supply communication satellit and their ground equipment. A go-ahead all that is needed and, most important— won't cost the taxpayer a cent.

Fourth, the questions you say shou be answered before a decision is reach have been answered—many times over- in recent months. The FCC is aware them. President Kappel of the A.T.&T. C has made many public speeches setti forth his company's position on owne ship, use, division of revenues . . .

In conclusion, I . . . quote from a rece speech by Mr. Kappel: ". . . the creation the satellite system we propose in order do our public service job as it ought to done would not under any circumstanc preclude the development of other spa communication systems for other purpos Space is a great big place and we do expect to fill it."

Ralph E. Burns
Beachwood, N.

(Continued on page 49)

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HE MISSILE / SPACE WEEKLY

nissiles and rockets

Volume 9, Number 1 July 3, 1961

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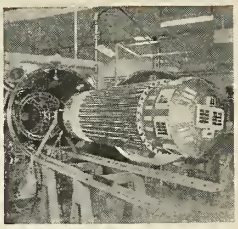
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THE COVER

NASA's S-55 micrometeoroid satellite emerges from vacuum chamber at Langley, during testing prior to scheduled launch last week on Scout 5. See p. 14.



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WASHINGTON

laxwell Taylor—Single 'Chief'?

There's mixed reaction inside and outside the Pentagon to President Kennedy's recall of Gen. Maxwell Taylor as his personal military representative. The question is being raised whether Taylor will become—in reality—a single "chief of staff" interposed between the President and the Joint Chiefs. Taylor's advice, in any event, is expected to weigh heavily in any military decisions involving the Berlin crisis—and he has held the view that if war came Russia could be stopped on the ground in Europe.

uclear Handwringing Ends

Much governmental handwringing—in evidence for a year or more—has ended with the decision to finally fly a small *SNAP* unit. A nuclear auxiliary power source was scheduled to go aboard a June 28 satellite package containing *Transit IV-A* just days before the flight. Even though units have been ready to go for more than a year, the government has held off in fear of international reaction.

ext Mercury Redstone Shot

Second *Mercury Redstone* carrying an astronaut on a ballistic flight path down the AMR is now set for some time in July 20-31 period. Changes in the capsule include a larger observation window, improved manual controls for "piloting" spacecraft in orientation phase, and a new escape hatch.

oubts on Dyna-Soar

Some Pentagon planners are siding with Defense Secretary McNamara in doubting whether it is possible to speed up the *Dyna-Soar* program (see p. 10). They are challenging, moreover, whether a space-bomber ever will be feasible or desirable because of the restrictions imposed by orbital flight. Look for a major behind-the-scenes fight on the release of extra *Dyna-Soar* money voted by Congress.

per Polaris Contract Due

COUNTDOWN hears award of the second-stage motor contract for the 2400-mile *Polaris A-3* is imminent. Chief contenders for the big program are Aerojet-General and Hercules Powder.

INDUSTRY

G Firing Bigger Solid Segments

Pursuing its big segmented solid-booster program, Aerojet-General expects to fire a 500,000-lb.-thrust motor in August and follow it up with a 1-1.2-million-lb.-thrust engine in November. Latter motor will have three segments and fore and aft sections, firing time of 65 secs., specific impulse of about 245.

NSIA Pushes Cost-Cutting

National Security Industrial Association is setting up 10 study groups to attack rising defense costs. The studies are probing into the problems of development leadtime, reducing engineering change-orders. One group looking into the over-abundance of specs in contracts already has submitted a report to DOD.

R&D Intelligence

Norair Division of Northrop has a $79,000 Air Force contract to study self-sealants for spacecraft. It will use its 8000 ft./sec. micrometeorite gun for tests. . . . Rocketdyne sees its J-2 engine coming in on or ahead of schedule in early 1963. . . . Rocketdyne also reports the F-1 engine has produced thrust of 1 million lbs. or more in 136 tests. . . . Navy's new VLF station (well over 1 million watts) at Cutler, Maine, may be tied into a military communications satellite network when it's ready.

Astronomical Error

JPL's Eberhardt Rechtin says the Russians are wrong in their astronomical unit of 92,812,797—perhaps because the Soviets used some old U.S. figures last April. The JPL astronomical unit is 92,956,000, and Rechtin maintains this is correct.

ComSat Battle (cont.)

General Electric considers it won a major victory with the Kennedy decision to put the commercial communications satellite issue up to the Space Council for resolution. This will delay an expected FCC decision in favor of A.T.&T. But GE's worry now is that the government itself may decide to take over the project.

INTERNATIONAL

Nord Sells AS-30

COUNTDOWN is told that at least one country—West Germany, Britain or France—has decided to buy Nord's air-to-surface *AS-30*. The bird is being offered to NATO countries as a competitor to the Martin *Bullpup*.

Space Interest Grows

The U.S. expects West Germany and Japan to join the growing list of nations cooperating in space projects. No agreements have been signed yet. Both countries are interested in weather and communications satellites.

Overseas Pipeline

West Germans, still haggling over conditions, are holding up announcement of the formation of the European space booster organization. . . . Short Brothers have opened a technical liaison office in Sydney, to handle its *Seacat* business with Australia and New Zealand. . . . Construction is underway at Goonhilly Downs, in Cornwall, for a British ground station to be used in U.S. communications satellite tests next year.

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'Better Liaison Between Industry and Government'

The Missile/Space Week

Alternative for Zeus

ARPA has picked a four-company team headed by Raytheon to devise an anti-missile method other than the Army's *Nike-Zeus*.

The program, called ARPAT (Advanced Research Projects Agency Terminal), will attempt to find a way to destroy ICBM's without the use of a nuclear warhead, as they near the end of their flights.

The two-and-one-half-year study, involving about $15 million, breaks down this way: $7 million for radar development by Lincoln Laboratories and Raytheon; $7 million, Hughes Aircraft for interceptor vehicles; $1 million for system planning split among Raytheon (30%), Boeing Co. (30%), Hughes (30%) and IBM (10%). Boeing will concentrate on lofter and supporting base facilities.

Shots of the Week:

First attempt at flight-testing the *Titan II* all-inertial guidance system (M/R, June 19, p. 18), as a passenger on a *Titan I* missile, was thwarted when the missile malfun tioned and fell short of its range.

It was launched from Ca Canaveral June 23.

Air Force plans to have the *Atl E* operational this year were set ba when the sixth missile in nine t firings at Cape Canaveral explod after 95 seconds of flight. The mish occurred June 23.

The Army scored a complete su cess with the final firing June 26 o *Redstone* missile, in an engineeri qualification program of producti missiles.

At Eglin AFB June 23, the A Force successfully fired a *Nike-Caj* research rocket for micrometeor study (see p. 40).

Also on June 23, Major Rob White again sped the *X-15* to a n speed record: 3690 mph, only 3 mph short of its intended maximu

The Navy shot but missed with advanced-model *Polaris* June Fired from the USS Observati Island, the missile was launched u eventfully, but missed its target "scores of miles."



RCA Moon Camp Conception

REMOTELY BUILT: Base camp on moon which would be placed and stocked by se of Saturn shots is envisioned by Radio Corp. of America artists. RCA proposes c structing a remotely controlled roving vehicle to survey lunar surface to find n appropriate area for manned landing. Entire operation would be checked out by gro instrumentation before man ever set foot on moon.

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nderson to Succeed Burke

Vice Adm. George W. Anderson, ow commander of the Sixth Fleet, as been chosen next Chief of Naval perations over about 10 admirals ith more seniority or rank.

Adm. Arleigh A. Burke retires ter three terms August 1.

esting Mercury Tracking

NASA will test its recently com-eted world-wide *Mercury* tracking twork late this summer.

The plan calls for orbiting a 100- satellite containing transmission d receiving equipment which will identical to the equipment in the *ercury* spacecraft.

The satellite will provide real-ne calibration, training and opera-on experience for the new 16-station *ercury* tracking network as well as bital flight test of *Mercury* com-unication gear.

It will be launched into a 300-ile orbit by a *Scout* booster. Satel-e package and booster will be pre-red for flight by Aeroneutronics stems Inc.

Working and communications uipment will be provided by Mc-onnell Aircraft Corp.

The satellite—to be called *Mer-ry Scout I*—will be launched from ape Canaveral.

ASA Reactor Goes Critical

Lewis Research Center's Plum ook reactor at Sandusky, Ohio, a clear test bed for spacecraft power its, began operating June 14.

Study of radiation effects on com-nents and materials for nuclear wer systems will be its primary nction. It will simulate radiation en-ronments of such power plants as *NAP* and *Rover*. Pumps, turbines, elding, propellant feed systems, ner components and materials will tested.

The reactor will be run at low wer for a short time to check op-ation and calibrate instruments, n shut down for a month-long EC inspection. After inspection, the actor will slowly be brought up to l power level of 60 megawatts.

rictly Academic

Latest move in the Soviet research akeup: the Academy of Sciences s been stripped of at least 30 of institutes.

Observers say the move reduces Academy's role to pure science. The institutes, all concerned with problems of application, have been transferred to other government departments. About 2000-3000 employees are affected. The Academy apparently will merely provide one part in the Soviet research machinery, which now puts major emphasis on technology.

President of the Academy is Mstislav V. Keldysh, a mathematician known for some time for his theoretical studies in areas of mathematics such as calculus of variations.

NASA-Argentine Project

NASA announced an agreement with Argentina on a cooperative space program using sounding rockets.

A memorandum of understanding was signed by NASA and the Argentine National Commission on Space Research.

The Argentine agency, as part of its space science research program, plans to conduct studies in the fields of meteorology, ionospheric physics and cosmic-ray detection utilizing rocket soundings.

NASA will provide, among other things, training facilities for certain Argentine scientists. It will also transfer small unnamed sounding rockets to be used in the launchings.

Any (Space) Bonds Today?

The Treasury Department has received a proposal that it issue "Savings Bonds for Space" to boost the U.S. space drive.



Proposed by the National Rocket Club, the bonds would be designated "Series S." The club has designed a special stamp bearing Astronaut Alan B. Shepard's likeness.

Although the Office of the Secretary of the Treasury has pointed out that funds raised by the bonds could not be earmarked specifically for the space drive, proponents of the plan say it would encourage scientists and astronauts—as well as provide an extra source of revenue.

A similar proposal was made recently by Sen. Kenneth B. Keating (R-N.Y.).

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House OK's DOD Funds . . .

Dyna-Soar Streamlining Urged

by William E. Howard

CONGRESS is attempting to prod the Kennedy Administration into a 3-year speed-up of *Dyna-Soar* to guarantee a manned orbital flight of the space glider in 1964.

But a move to implement "Project Streamline" by earmarking an additional $85 million above the $106 million in the FY '62 budget for *Dyna-Soar* met little enthusiasm at the top of the Pentagon.

Said Defense Secretary McNamara: "I doubt very much that we can expend that effectively and efficiently but I certainly wish to re-examine the problem."

The beef-up in *Dyna-Soar* funding was one of the main new features of the $42.7-billion FY '62 military appropriations bill as it passed the House last week—a $2.4-billion increase over FY '61. The House also disagreed with McNamara's assessment of the need for manned bombers and provided $448 million in new obligational authority for long-range bombers.

The bill, which was expected to receive speedy Senate approval, contained $231 million less than was asked by President Kennedy in his $1.9-billion add-on to the Eisenhower budget. But $225 million of the reduction was considered "technical," since the same amount will be transferred from unused prior-year funds in the Air Force's procurement account.

Going along with the House Appropriations Committee's sharp disapproval of military procurement techniques, the House voted a 2% across-the-board cut in all procurement accounts amounting to $308 million. The cut last year was 3%.

How the House broke down major funding:

ARMY

Appropriation — $10,359,000,000, $38.7 million over the budget request.

Procurement of missiles and equipment—$1,991,400,000, down $20.6 million.

RDT&E—$1,202,700,000, down $2.7 million.

O&M—$3.3 billion, up $8 million.

NAVY

Appropriation—$13,458,000,000, a $110,598,000 reduction.

Procurement of aircraft and missiles—$2,148,000,000, a $43.8-million decrease.

RDT&E—$1.3 billion, reduced by $5 million.

O&M—$2.7 billion, down $25 million.

AIR FORCE

Appropriation—$17,583,000,000, a $143-million reduction.

Missile procurement — $2,736,000,000, a $55.8-million decrease reflected in the 2% cut.

Aircraft procurement—$2.9 billion, a $72-million reduction.

Airlift modernization—$320 milli a $22-million increase.

RDT&E—$2 billion, up $60 milli

O&M—$4.3 billion, down $ million.

The Appropriations Commit charged into DOD on *Dyna-Soar*— claring that program planning "to d has lacked boldness and imaginatio Apparently picking up a Boeing plan approved and advanced by G Bernard Schriever, the committee s "Project Streamline" could acceler manned orbital flight by three ye Total cost of the program, moreo could be reduced by about $300 mill by the speed-up. It said the accelerat could be accomplished by:

—Using the *Saturn* booster to the glider in orbit.

—In early flights, substituting av able subsystems developed in other p grams for more complex subsyste being developed for use in *Dyna-So*

The committee made it clear w the speed-up was necessary.

"The potential military applicati of the program are important. For t remainder of this decade the space a close to the earth's surface will be greater interest to military planners th will the area around the moon."

In attacking the program, congre men contended that *Dyna-Soar* w being pursued at less than optim pace. The Air Force had let it be kno that it expected to start orbital flig in 1964-65. But apparently this w not really the case.

Defense officials queried by M this week maintained that there h been no change in the original tir table for the program since it was in ated more than a year ago. This tir table calls for an orbital flight in Ap 1967 aboard a *Titan C* (which app ently never has left the drawing boar

The speed-up, which the commit claims is feasible, would advance date to early 1964, possibly late 19 However, *Saturn* becomes a controll leadtime factor; there are no offic connected with this booster progr who say it will become "man-rat before 1964 or 1965.

There apparently are some gr differences of opinion on the value f *Dyna-Soar* as a weapon, even if it s feasible. Although no one has attacl it publicly, some DOD officials p out that it has certain drawbacks a bomber because it is tied to an or

(Continued on page 42)



Vulcan Bomber with Skybolts

BRITISH VULCAN Mk II bomber is at Edwards AFB for compatibility tests with Douglas Skybolt. Aerojet-General has already fired flight-weight motors for the missile.



A.T.&T.'s PROPOSED satellite system.

or phone satellites . . .

Council Favors Private Ownership

by Hal Taylor

THE NATIONAL Aeronautical and Space Council—President Kennedy's space advisory group—leans heavily in favor of allowing private enterprise to own and operate a commercial communications satellite system.

Dr. Edward D. Welsh, executive secretary of the group, said—in referring to industry fears that the Kennedy Administration may decide to set up a government-owned system—that "there is no basis for that view."

Dr. Welsh's declaration was the latest development in an already muddled situation surrounding the question of who should own and operate communications satellites.

It followed President Kennedy's order to the council early last week calling for a study to determine how the system can be brought into operation "at the earliest possible time."

The policy proposals, the President said, should include recommendations on "the nature and diversity of ownership and operation" of a satellite system.

The President's action came shortly after the Justice Department informed the Federal Communications Commission that its tentative decision to award ownership of a commercially-operated system to certain international communications carriers "might violate antitrust laws."

The Justice Department stated its position as several space industry firms, led by General Electric, petitioned the FCC for the right to share in the ownership.

• **Reassurance**—While officials of missile/space industry companies involved welcomed the President's action —which in effect will delay and influence a final FCC decision—they indicated that they are worried by the sense of "urgency" conveyed in the President's order.

They fear that the Administration, in its haste to beat the Russians in setting up a space communications system, will turn to a government-owned and -operated system based on NASA's Project *Relay* program presently in the development stage.

Dr. Welsh, however, threw cold water on the whole idea. He said that the Council has already held several meetings with representatives of interested federal agencies and that "vast majority of opinion is that the system should be owned by private enterprise."

He said, however, that the commercial firms involved in the controversy have "over-simplified the whole project," and this is reflected in their belief as to how fast they could get it working.

The Administration official noted that many tests have to be made, an apparent indication that NASA will continue to have a large development role in the project.

It is also possible that the Administration policy will call for more government-industry cooperation in the project. This was hinted at by President Kennedy, who told the Council that any satellite system should be global in nature and capable of serving all the continents and underdeveloped nations.

"I am anxious that this new technology be applied to serve the rapidly expanding communications needs of this and other nations on a global basis, giving particular attention to those of this hemisphere and newly developing nations throughout the world," he said.

Since many of the underdeveloped nations do not have the funds necessary to build the ground stations needed to take part in the system, it is thought likely that the government may wish to provide such funds through foreign aid programs.

(Continued on page 40)

In three styles . . .

Douglas Proposes Beefing-up of I

'Thorad' family would double present payload capacity wit relatively easy modification, fill gap between Thor and Atl



M/R ARTIST'S CONCEPTION of blastoff of Thorad Jr., with Little Joes attached.

SANTA MONICA, CALIF.—An a vanced version of the *Thor* spa booster is being proposed by Dougl Aircraft Co. to double the present v hicles' payload capacity.

Designated *Thorad,* the new boost requires no major modification in t basic *Thor* vehicle, the company sa and hence could be flight-tested with one year after initiation of developme

The advanced booster comes in thr designs—*Thorad, Thorad Jr.* a *Thorad B.*

—*Thorad* would have a consta diameter airframe, instead of the pr ent tapered frame of *Thor.* This wou permit the addition of 35,000 gals. propellant for longer burning. The would be no change in the 165,000-l thrust Rocketdyne engine.

—*Thorad Jr.* would be the ba 165,000-lb.-thrust *Thor* space boost with unaltered tanks but with thr Thiokol solid-propellant *Little Joe* ro ets fastened to its sides to boost to takeoff thrust to 315,000 lbs.

—*Thorad B* would be the great departure from the present *Thor,* havi a Rocketdyne H-1 engine with 190,0 lbs. of thrust, a constant tank diame of eight feet and three *Little Joes* additional thrust.

W. H. Hooper, Chief Project E gineer, Thor Space Vehicles, said company has studied vehicles using so rockets larger than *Little Joe.* But declined to say how much larger rockets would be, or what conclusio the studies have reached.

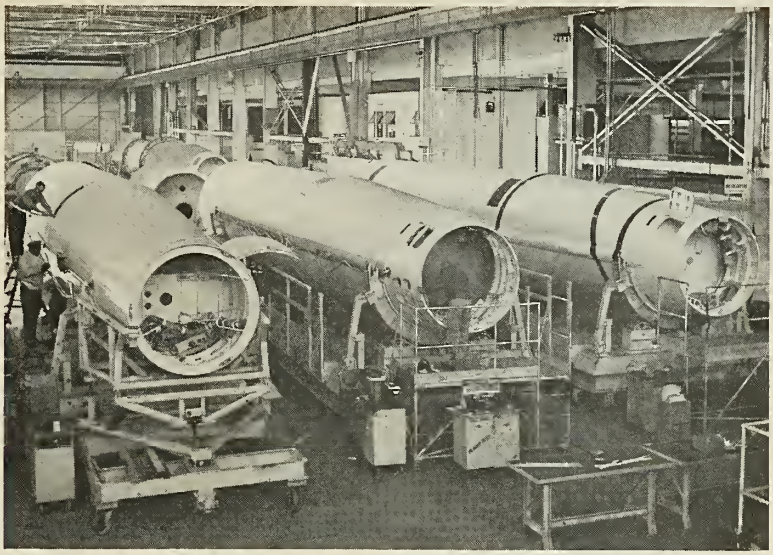
Douglas also declined to say wi Air Force or NASA interests involved in the proposals.

• **Easy changes**—Basic to the c cept of advanced *Thor* vehicles is fact that no major re-working of ex ing designs or hardware would be quired. Modifications likely to ca stability, structural or other proble are avoided in the Douglas plans; would launch facilities need ma revision.

With the 54,500-lb.-thrust *Little* rockets attached, *Thor* would achi 315,000 lbs. takeoff thrust, lasting

ıor Booster

by Frank G. McGuire



TRIO OF THOR VEHICLES on assembly line at Douglas-Santa Monica. Left to right are boosters for Thor-Delta, Transit and Discoverer programs. Note the varying transition sections, with second-stage-exhaust venting ports and internal differences. Aft of the transition section, however, Douglas is now making all Thor vehicles identical.

ɔut 28 seconds before the solid ckets would burn out and, shortly terwards, be jettisoned. A single attach ɔint would hold each of the three solid ckets to the side of *Thor*, with a lower ut used to add stability and prevent rning of the *Little Joe*.

Explosive bolts, actuated electrically ɔm the ground, would free the solid ckets, which would be peeled away aerodynamic forces much as in the itish *Bloodhound* missile design. ange safety considerations would be major factor in determining when the plosive bolts were triggered.

Canted nozzles on the *Little Joe* ıits would direct the thrust component rough the center of the *Thor* by way the upper attaching strut. Thrust ctor control for the vehicle would be aintained by the main engine which ɔuld be gimballed.

Gross weight added to the *Thor* by e modifications would be about 25,000 s.; each solid rocket would contribute ughly 8000 lbs. of this, and miscelneous hardware the remainder.

No vibration problems are anticited with the modified design, although e overall acoustical level would rise.

The solid rockets would be ignited ternally and automatically by the ndard *Thor* equipment, and the igniɔn would always be accomplished fore liftoff.

Beefing-up steps desirable for ineasing *Thor's* performance can be complished in the field, the company ys.

• **No ignition fears**—The question mission completion should one or ɔre solid rocket boosters fail to ignite apparently causing Douglas little ncern. Hooper points out that solidcket reliability is very high, and if an ctrical circuit failure should cause ɔblems with one of the solid rockets, e mission could still be carried out.

A degraded mission could be accomshed if none of the solid boosters iged, and these would be dropped as ɔn as possible in order to minimize ag. With one unignited solid rocket the system, *Thor's* gimballed main engine could compensate for the unequal drag caused by the dead rocket's presence until ejection of all solid units is accomplished.

Internal modification of the *Thorad* and *Thorad B* due to tankage expansion (*Thorad Jr.* involves no internal airframe changes in the basic *Thor*) would be slight—principally eliminating taper in forward sections and shifting the central bulkhead a bit forward to allow proportional changes in the capacity of each tank. Total increase in propellants by this move would be 35,000 lbs.

The boattail section and thrust beams would also have to be beefed up in the *Thorad B* version, to take the added push of the H-1 engine.

Altitude of the *Little Joe* ejection would be controlled by range safety, the flight trajectory followed and the weight of upper stages employed.

Douglas says it first tried attaching the *Little Joe* boosters flush against the *Thor* boattail section, but found that ejection problems were unjustifiably severe. Mounting on extended struts alleviated the problem and allowed aerodynamic forces to do the job. Although the design is still somewhat flexible, the space between the solid rockets and the *Thor* is expected eventually to be about a foot or less.

• **Stock items?**—If a customer is found for the *Thorad* proposal, Douglas expects to buy *Little Joe* units directly from Thiokol Chemical Corp. as a stock item.

Douglas feels that the entire vehicle would find a place, in terms of capability, between the present *Thor* space boosters and the *Atlas*-based space boosters. The company points out that a majority of U.S. satellites have been put into orbit by *Thor* vehicles, and that advantage should be taken of the booster's reliability record.

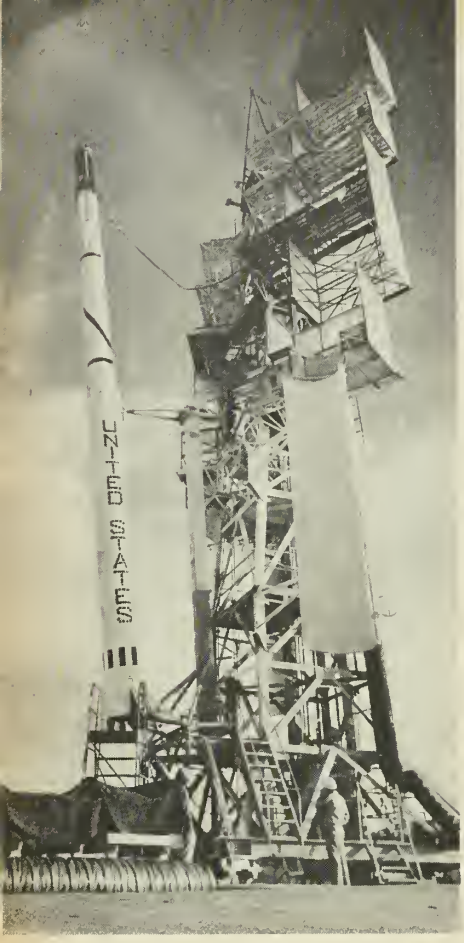
• **Present Thor**—Current *Discoverer*-series models of the *Thor* itself, thanks to numerous changes in design, have a payload capability 7000 lbs. greater than that of the initial tactical configuration. The 7000-lb. figure includes everything above the nose transition section of *Thor*, and assumes a low-orbit mission. Douglas has changed the vehicle designation from its original DM-18 to DM-21 (Douglas Missile 21) as a result of the product improvement program.

Part of the modification includes shortening of the upper transition section by 5½ ft.—a move which cut 400 lbs. from the airframe weight, and was made possible by eliminating the all-inertial guidance system and relocating the battery and inverter of the flight controller used on space models.

Other changes introduced by Douglas include substitution of lightweight aluminum for fiberglass tunnels carrying circuitry from the guidance to engine compartments; strengthening of engine compartments to accommodate the Block II Rocketdyne engines; and strengthening of the tank section bulkhead for the same reason.

The company estimates that more than 400 changes have been made to date. Although the exterior appearance

(Continued on page 42)



As secondary mission . . .

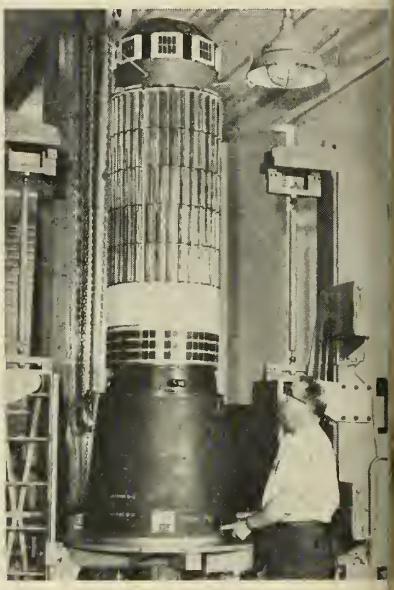
S-55 Hitchhikes on Scout 5 Solid Booste

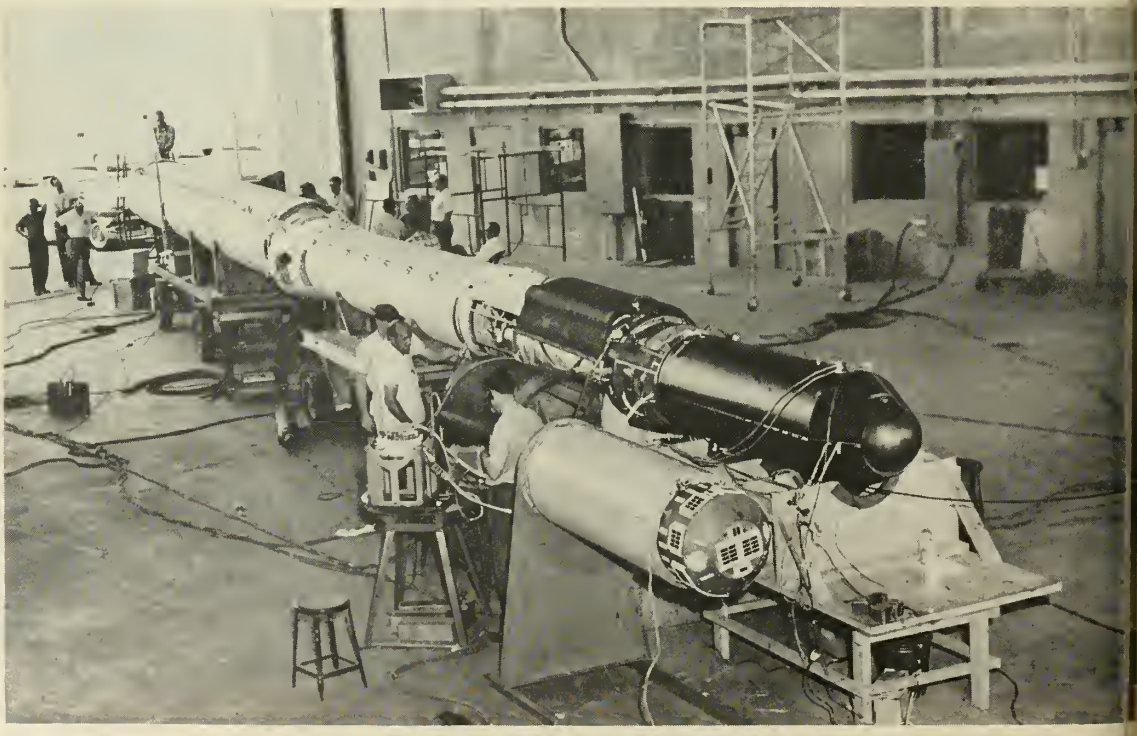
NASA's Scout No. 5—scheduled for launch last week at Wallops Island—was a double-barreled effort primarily to test the four-stage solid rocket. Putting the hitchhiking *S-55* Micrometeoroid Satellite (M/R, June 12) into orbit was only a secondary mission.

LEFT: *Micrometeoroid satellite (S-55) sits atop Scout 5 as only U.S. solid-fuel satellite booster is readied for launch at Wallops Island.*

RIGHT: *Scout's fourth-stage motor serves as carrier for hitchhiking micrometeoroid experiments.*

BELOW: *Complete Scout with payload is checked out at Langley prior to assembly at launch pad.*





Rubel Blasts DOD 'Tailfinism'

DOD'S JOHN RUBEL has taken a ard look at the Pentagon's weapon lanners and finds them guilty of "tail- nism."

There's a strong tendency, says ubel, toward "overstated requirements nd degrees of automation or miniaturi- ation considerably beyond the point of iminishing returns in operational effec- veness."

In a speech at the Fifth National nvention on Military Electronics in Vashington, the deputy director of Re- earch and Engineering let fly several ther roundhouse swings at his own de- artment.

He accused DOD of coddling poor dvanced weapons system planning, of ondoning duplication among individual gencies, and of allowing some projects o proceed in a "vacuum" so that ob- lescence was built-in.

To reverse this sorry situation, Rubel aid:

—DOD's advanced planning must ssume a "more forward-looking and etter integrated character"—specifi- ally in unifying R&D planning and in anaging R&D "from basic research on hrough hardware procurement."

—The team effort between DOD nd industry must be "redeveloped" to nsure that only those items that are eeded—and attainable—are under- aken.

—Everybody must always be aware f the "abiding requirement for high- rade engineering effort in the most owly parts of every system."

—"Finally, we must wage an unre- lenting fight against the tendency for lead times to stretch out in any of the many ways this can happen, and project our development goals so that our de- ployed systems can enjoy a reasonably long and useful life."

More than 3000 MIL-E-CON participants, representing scientists, engineers and business executives directly concerned with the military electronics field, attended the three-day session, sponsored by the Professional Group on Military Electronics of the Institute of Radio Engineers.

Rear Admiral Frank Virden, director of Naval Communications, was the keynoter, calling for "good citizenship in the frequency spectrum." If this is not achieved, the admiral warned, "the building of the tower of Babel will be enacted all over again in this nation to our complete confusion and possible electronic strangulation."

He also stressed that developments in Command and Control systems must emphasize integration, survivability, sureness and flexibility.

The 1961 M. Barry Carlton Award for the best paper published in the *IRE Transactions on Military Electronics* was presented to William B. Glendinning, Army Signal Research and Development Laboratory, Fort Monmouth, N.J., by Dr. Witting, chairman of PGMIL, at a special awards luncheon. Glendinning's paper, published in the October, 1960, *Tranactions,* was entitled "Silicon Integrated Circuits." ⌘

Alaska BMEWS Station Operational

THE SECOND Ballistic Missile arly Warning System (BMEWS), at lear, Alaska, went operational this eek.

First of these giant 3000-mile-range ir Force radar systems—at Thule, reenland—has been in operational tatus since October, 1960.

The third segment of the mammoth adar fan will be completed next year t the Fylingdales Moor site in York- hire, England.

Prime contractor for the almost $1- illion program is Radio Corporation of merica.

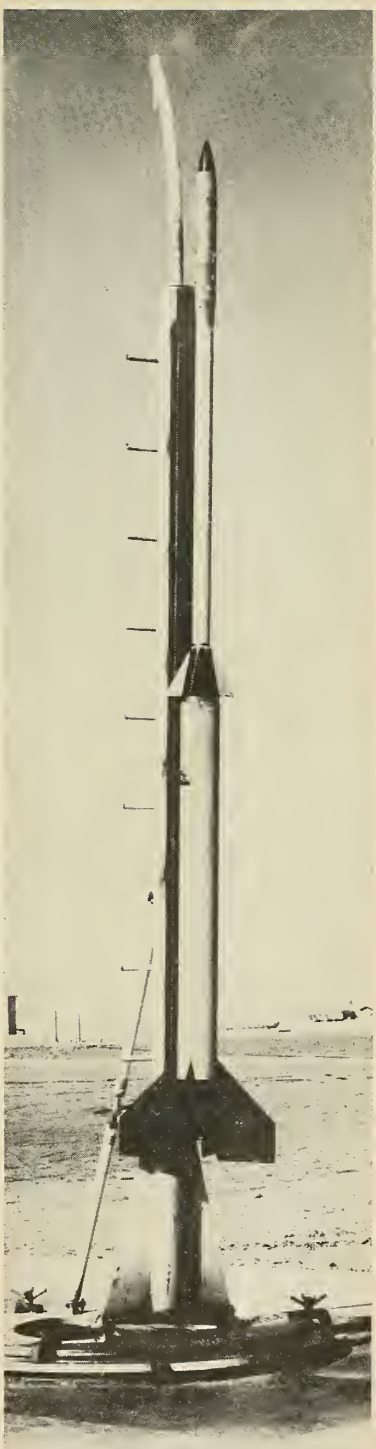
The Clear BMEWS station is almost dentical to its predecessor in Thule, mploying three gigantic torus-shaped earch radars (165 ft. h. x 400 ft. lg.). ventually, two 85-ft.-high tracking ishes will be installed at each of the ites. Tracking radars, being built by oodyear Aircraft Corp., have been nder test and evaluation for over a ear now, but Department of Defense udget limitations have delayed produc- tion. Three of the trackers, however, will be installed in England, since the General Electric surveillance radars are not scheduled for installation there.

• **Switch in supports**—Only significant change in its surveillance radar screens, according to G.E.'s Heavy Military Electronics Dept. is the use of 70-ft.-long steel latticework backstays. Twenty of these support each reflector, replacing the tubular steel structural members employed at Thule. The latticework supports were necessary, said a department spokesman, to withstand the heavy earthquake tremors and 110-mile/hr. winds which could be experienced in Alaska. Each of the antennas weighs 900 tons, he said.

The reflectors were built for G.E. by D. S. Kennedy & Co., Cohassett, Mass.

Cost of the Clear station is expected to reach about $330 million—about $170 million less than the Thule complex.

(For hardware, subcontractor, and system details refer to M/R, May 23, 1960, pp. 36-40.) ⌘



Kisha-Judi Rocket

FIRST PHOTOS of Rocket Power Inc.'s new Kisha-Judi sounding rocket. The two-stage vehicle weighs 221 lbs. and can reach maximum altitude of 480,000 ft. with top 2nd-stage velocity of 3271 ft./sec.

Aerojet Bets on Space-General Corp.

Parent firm ready to invest several million dollars in subsidiary established with view to major contracts

AEROJET-GENERAL is making a major bid to expand its missile and space systems business by setting up a wholly-owned subsidiary—Space-General Corp.

The move, maintains Aerojet President Dan A. Kimball, is independent of any corporate jockeying for position in the competition to build a multi-mega-pound-thrust solid booster for the Air Force (M/R, June 26, p. 14).

However, officials of the new subsidiary concede that they will be seeking contracts for such major projects as the *Saturn S-II* stage that could be undertaken "either by Space-General or Aerojet." Space-General will not have any propulsion facilities of its own for the present. But this eventuality is not being ruled out. Says Kimball:

"Other elements of Aerojet may be merged into Space-General in the future."

Kimball told MISSILES AND ROCKETS that no major company realignment is contemplated in the competition for the contract to develop the big solid booster, which is expected to run to $500 million for motor R&D alone in the next three years.

"We have the capacity—plenty of it," he said. "In fact our mixing plant at Sacramento is running at only 40% of capacity right now."

But the former Navy secretary said that Aerojet already is anticipating the need for more space to fabricate and test big solid motors and "we have a crew out looking at sites right now." If it lands the solid *Nova* contract, Kimball says, Aerojet also would have to build a new continuous mix plant.

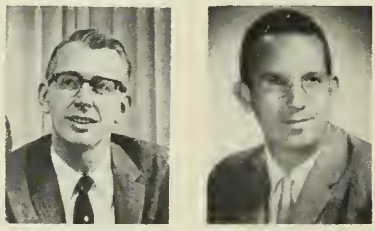
• **Growing to 1600**—Billed as a "major organizational move" prior to its announcement last week in Washington, Space-General is formed out of Aerojet's recently established Spacecraft Division and Space Electronics Corp., a company acquired late last year as a subsidiary.

Dr. James C. Fletcher, president of Space Electronics, is heading up Space-General; Frank W. Lehan, formerly executive vice president of Space Electronics, takes over the same post in the new organization.

Aerojet says the company is starting off with a business base this year of $20 million. It has about 800 employes and the payroll is expected to grow to 1600 by next July.

The company is presently headquartered at Space Electronics' old facilities in Glendale, Calif., but will move early next year to a 200,000-sq.-ft. plant east of Los Angeles.

Target areas of effort by the new company include, besides *Saturn S-II:* a "new type" navigational satellite; the *Vela Hotel* spacecraft for detecting nuclear explosions in space; orbital spacecraft with offensive and defensive systems; SARUS search and rescue sat-



SPACE-GENERAL president Dr. James C. Fletcher (left) and v-p Frank W. Lehan.

ellite; and development of terminal guidance for ICBM warheads—as well as other advanced projects.

• **Miniature moonmobile**—Going projects include continuation of Aerojet's *AbleStar* upper stage motor, *Aerobee* and *Astrobee* space probe vehicles and instrumentation for the *Ranger* and *Surveyor* lunar spacecraft.

S-G is planning to follow through on a proposal to NASA to build a "miniature moonmobile" weighing about 300 lbs. that could speed up lunar exploration to 1963 or sooner. It would be soft-landed with an *Atlas-Centaur* and essentially combine the functions of *Surveyor* and *Prospector,* a 1500-lb. exploratory vehicle that has been scheduled for 1966-67.

Employing a *Surveyor* landing gear, the moonmobile would be able to survey the lunar surface over a 1500-mi. range, using TV to pick out manned vehicle landing sites, as well as sample and send back to earth analyses of the lunar crust

Aerojet expects to put several mil lion dollars into S-G. Says Kimball:

"The new corporation represents the necessary blend of know-how in elec tronics, propulsion, structures, and sys tems concepts, as well as assembly an fabrication of missile/space systems. W decided to bet our money on it."

mergers & expansions

FAIRCHILD STRATOS CORPO RATION announces several divisio name changes. The former Astronic Division is now the Electronic System Division and the company's St. Augus tine, Fla., operation is now the Aircraf Service Division. In May, Fairchil changed its name from Fairchil Engine and Airplane Corp. to it present title.

WEAPONS INDUSTRY CON SULTANTS, INC. has been formed t supply market intelligence to the de fense industry. Founded by John H Kelly, the firm's staff is composed o management personnel formerly assc ciated with defense-contract holders Services will include a weekly Curren Market Intelligence report, follow-o intelligence collection for client's spe cific requirements, specialized mark research reporting of any technica management, marketing, or conceptu weapons development for clients, ne contract opportunities and recommer dation of optimum market intelligenc systems after analysis of client's firm Home offices are at 7928 Ivanhoe St La Jolla, Calif.

MEMOREX CORPORATION Santa Clara, Calif., was formed to spe cialize in the field of electronic memor and to develop advanced materials an technology related to the field. A plan is under construction and productio of high-precision magnetic tapes will b ready for marketing next year.

THE MARTIN COMPANY an American-Marietta Company have an nounced merger plans, pending stock holder approval. Martin board chairma George M. Bunker will be Chairman o the Board and President of the as-ye unnamed company. Grover M. He

nann, Marietta Board Chairman, will ɔe Vice President. No date has been set or a stockholders' meeting. A joint tatement said "It is anticipated that the iew company will be in a position to erve better its government and military customers. . . ." American-Marietta produces building supplies and other prodicts.

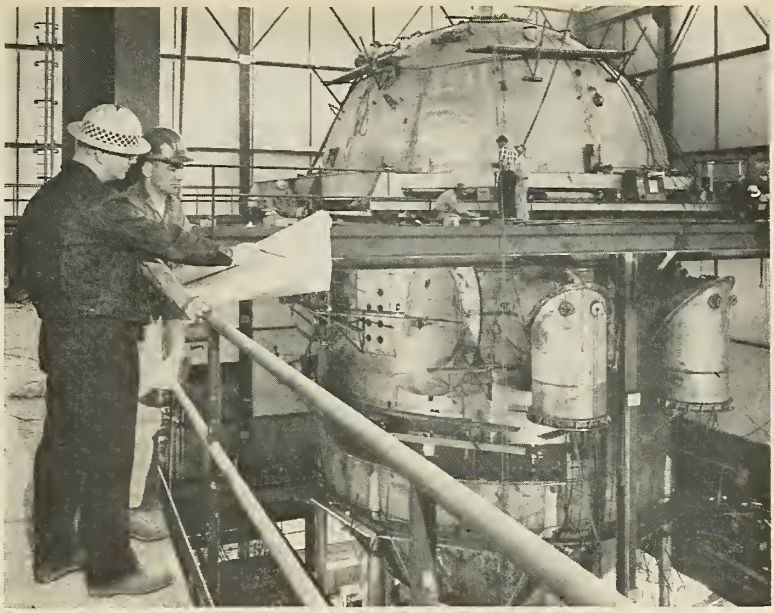
SMITH THERMOTRONICS, NC., is the new name for E. C. Smith Company, Conshohocken, Pa., manuacturers of thermocouple temperature neasuring elements and accessories.

DYNAMIC INSTRUMENT COR-'ORATION acquired Vibration Research Laboratories through exchange f stock. The parent company is a lesigner-manufacturer of precision magietic clutches and brakes for applications in subsystems aboard missiles, aircraft and submarines. Vibration Research, a prime developer of solid-state ower conversion equipment, developed complete power supply system for the *Atlas, Thor* and *Jupiter* missiles.

LEAR, INC. is putting $3.5 million nto a plant expansion program at its nstrument Division at Grand Rapids, Mich. Lear's first-quarter earnings this ear were $510,000—about 10% over ast year—on sales of $22.5 million—% over the same period last year.

LOCKHEED AIRCRAFT CORP. enamed its missile-satellite organization he Lockheed Missiles and Space Comany, and established three divisions ithin it—Space Systems, Missile Systems, and General Services, Lockheed 'resident Courtlandt S. Gross said the eorganization "will provide more direct nd effective communication between the company management responsible for the missile and space activities and the cognizant government agencies on one hand, and between the missiles and space organization and the corporation on the other hand." The new company will continue to operate as a division of the parent organization.

WYLE LABORATORIES, El Segundo, Calif., has placed two mobile labs from its Field Service Department at U.S. Air Force bases to meet inspection and calibration requirements of advanced missile and aerospace components and systems. A 40-ft. unit at Plattsburg AFB, N.Y., is equipped to perform analysis of gases, liquid fuels and oxidizers. It incorporates an office and lab, including a separate area for microscopy. A 20-ft. standards and calibration lab in service at Chanute AFB, Rantoul, Ill., is designed to perform instrumentation calibration and checkout during control system testing and system validation.



Largest U.S. Space Simulator

NEARS COMPLETION: General Electric's $6-million space environment simulation laboratory nears final construction at Valley Forge (Pa.) Space Technology Center. The 54-ft.-high simulator will be large enough to test manned vehicles and capable of producing almost total vacuum and temperatures lower than —300°F, and reproducing "effects" of solar energy in space.

CONTROLS COMPANY OF AMERICA formed a new Astromatic Division, with offices and plant in El Segundo, Calif. The new division had functoned as part of the Control Switch Div., but the company says increasing demand for components and systems required setting up a separate facility.

AIR PRODUCTS, INC. acquired 100% interest in its British subsidiary, Air Products Limited, through exchange of over $2.4 million cash. Leonard P. Pool, Air Products' President, said the acquisition was made "to strengthen our position in the British Commonwealth and European Common Markets." Air Products Limited, with sales over $5 million, is principally involved in design, manufacture, installation and operation of oxygen plants and other cryogenic equipment.

Financial Reports

COMPANY	PERIOD	INCOME		EARNINGS	
		1961	1960	1961	1960
Airpox Electronics	3 mo. Mor. 31	$ 1,056,979	$ 952,911	$ 27,420	$ 16,072
Ampex Corporotion	Yeor, Apr. 30	70,105,000	73,434,000	—4,000,000	3,959,000
Amphenol-Borg	3 mo. Mor. 31	13,767,900	15,562,129	123,735	789,182
Collins Rodio Company	9 mo. Apr. 30	164,145,046	138,991,830	2,700,117	5,901,605
Dorne & Morgolin Inc.	Yeor, Mor. 31	2,086,111	1,678,664	41,459	44,150
Loborotory for Electronics	Yeor, Apr. 30	50,929,000	48,114,000	1,891,000	1,648,000
Ryon Aeronouticol Company	6 mo. Apr. 30	45,831,290	51,039,813	1,174,867	881,010
Sperry Rond	Yeor, Mor. 31	1,176,999,343	1,173,050,913	27,815,655	37,235,823

Collins attributes lower earnings despite greater sales an R&D expenses, "unusually large" pre-production and tart-up costs and facility improvement and operating processes.

Increased technical responsibilities in the field of range measurements have required the creation of new positions at the Lincoln Laboratory. We invite inquiries from senior members of the scientific community interested in participating with us in solving problems of the greatest urgency in the defense of the Nation.

RADIO PHYSICS and ASTRONOMY

RE-ENTRY PHYSICS

PENETRATION AIDS DEVELOPMENT

TARGET IDENTIFICATION RESEARCH

SYSTEMS: Space Surveillance
Strategic Communications
Integrated Data Networks

NEW RADAR TECHNIQUES

SYSTEM ANALYSIS

COMMUNICATIONS: Techniques
Psychology
Theory

INFORMATION PROCESSING

SOLID STATE Physics, Chemistry, and Metallurgy

A more complete description of the Laboratory's work will be sent to you upon request.

All qualified applicants will receive consideration for employment without regard to race, creed, color or national origin.

Research and Development
LINCOLN LABORATORY
Massachusetts Institute of Technology
BOX 26
LEXINGTON 73, MASSACHUSETTS

SANGAMO ELECTRIC CO. has purchased a controlling stock interest in Microsonics Inc., of Hingham, Mass., manufacturers of delay lines. An immediate and rapid expansion of the research and development facilities of Microsonics is planned.

CAMBRIDGE SCIENTIFIC INDUSTRIES, INC., has been formed at Cambridge, Md., to design and manufacture electromechanical devices for the electronic and aircraft industries. Formation of the new firm was announced by Donald A. Holdt, former executive vice president of Airpax Electronics.

GANLON INDUSTRIES, INC. has been formed to provide research, design and production services on contract to industry and government agencies. The new Glen Cove, N.Y., firm will specialize in engineering and design of digital data handling systems, analog control systems, automatic checkout equipment and transistorized circuit design. In manufacturing service, the company will give special attention to electro-mechanical assembly, prototype wiring, cable and harness fabrication with methodized fabrication techniques and established quality control procedures.

ALPHA METALS, INC., will open a manufacturing and sales division in London next month. The new European division will supply overseas semiconductor device manufacturers with high purity microminature metal forms, and continuous conductive solder-coated base metals for base tabs used in production of germanium devices.

reviews

ATLAS OF THE OTHER SIDE OF THE MOON edited by N. P. Boroboshov, A. A. Mikhoilov Yu N. Lipskiy, first published by the Academy of Science of the USSR; Pergomon Press, Heddington Hill Holl, Oxford, Englond, 171 pp. $7.00.

This is a good translation of the Russian report explaining the derivation of the map of the other side of the moon. It may be remembered that information for such a map was radioed to Russian ground stations from a Soviet moon vehicle launched Oct. 4, 1959.

A GUIDE TO TECHNICAL LITERATURE PRODUCTION, Emerson Clorke. TW Publishers, Box 151 River Forest, Illinois. 180 pp., $3.

The Guide is a quite thorough handbook designed for the company buyer, producer or writer of technical literature.

It deals with the problems of personnel; number needed, how to train writers, where to recruit and what to pay them. It also covers production cost factors, and outlines possible planning schedules. There are chapters on filing systems, production operations and the use of writing agencies.

Technical Countdown

ELECTRONICS

Recovery Problem Underestimated

Rumors persist that NASA *Apollo*-study reviewers are disappointed in the guidance and control aspects of the project as reflected in all of the submitted reports. Chief problem seems to be a general lack of real comprehension of re-entry and recovery problems. These were anticipated in the *Dyna-Soar* program by the Air Force and Boeing, who accordingly let several long-term research contracts which are now in progress. NASA has already been briefed on the results to date of these studies.

Crystal-Can Relay Size Halved

A crystal-can relay developed by Leach Corp. offers a 50% reduction in volume requirements for printed circuits. The tiny relay weighing 0.25 oz. and occupying 0.128 cu. in., frees design engineers of the need for laying relays down horizontally and requires no hold-down tabs. It employs a single-coil electromechanical circuit in place of the two coils used in conventional subminiature crystal cans.

Thin-film Functional Circuits Studied

Motorola has just received a $1.5-million AF contract to study compatible techniques for integrated circuit functions. The Semiconductor Division in Phoenix will combine semiconductor processes and thin-film technology to obtain single-crystal functional circuits. The contract is of the cost-sharing type, with Motorola bearing the brunt of the costs.

Low-Price Power Transistors Possible

A new encapsulation technique developed by Philco's Lansdale Division reportedly permits a quadruple power dissipation increase in the division's high-frequency MADT transistors. These components have wide current use in high-speed computer circuits and communications equipment. The breakthrough involves use of a medium that doubles thermal conductivity between transistor junction and base. The trick is to achieve very-high-density loading of carefully graded alumina in an inert vehicle of polysiloxane fluid which has a service range from −100°F to +400°F. The transistors use low-priced germanium.

Reds Press Maser Research

Izvestia recently reported that Soviet scientists, using a getter-ionic pump and cooling to achieve a vacuum level of 5×10^{-6} mm Hg, have operated a sealed-off ammonia maser oscillator continuously for six days. By using a getter-ionic pump with a 700 liter/sec. evacuation rate, Gor'kiy University researchers say, it will be possible to operate the maser continuously for about two months.

Breakthrough in Transformer Miniaturization

Researchers are finally getting around to doing something about the size and weight of transformers—until now an anachronism in the era of miniaturized components. Dr. Richard McFee, of Syracuse University and Arthur D. Little, Inc., has found a way to utilize the advantages of superconductivity in a transformer design, while avoiding its limitations. Basically, the new technique uses interleaved layers in the transformer to cancel out the magnetic fields usually generated about the windings, which quench the superconductivity.

SUPPORT EQUIPMENT

AF Buys RACEP

The Air Force became The Martin Co.'s first customer for the new RACEP multi-channel voice communication system (M/R, June 12). Electronic Systems Division, AFSC, bought six of the newly developed units for testing as ground-to-ground links.

Missile U. Adds Courses

Army Ordnance has added three courses on the improved *Nike-Hercules* weapon system at the Redstone Arsenal missile school. The new courses are primarily concerned with the Hipar radar recently added to increase the system's effectiveness about tenfold. Curricula of the school now includes 69 courses covering eight weapon systems.

Surveillance Radar Being Mobilized

The Signal Corps has started a development program to put the TPS-25 radar on wheels, making it the first mobile ground surveillance radar. Installed in an M-257 armored amphibious carrier, the radar will be capable of speeds of 40 mph on land and 4 mph on water, and delivery by air-drop.

ADVANCED MATERIALS

Silicone Rubber for Re-Entry?

G.E. scientists have subjected silicone rubber compounds to 9000°F for six minutes. A full 70% of the material remained flexible after exposure, although a hard, carbonaceous crust formed on the surface. Temperatures behind the sample reached only 450°F.

Disappearing Conductor

Molybdenum trioxide, formed when the metal reaches 1500°F in air, acts as a conductor and short-circuits electrical systems. When returned to room temperature, the oxide becomes an insulator. Boeing engineers discovered the phenomenon during simulated *Dyna-Soar* space flights. Even small quantities of the vapor escaping from tiny cracks in the moly protective coating could penetrate high-quality aircraft wiring.

Liquid Hydrogen Construction Begins

Chemical Construction Corp. is erecting Linde's multi-million-dollar liquid hydrogen plant at Fontana, Calif. Scheduled for completion by June, 1962, the plant will supply 21 tons a day to West Coast rocket centers under a $31-million NASA contract with Linde Co.

Electrically Boosted Flames

An economical heat source capable of supplying energy in the 3000° to 6000°F range has been patented by an engineer at Arthur D. Little, Inc. The concept involves boosting the energy from fuel-oxidant combustion by superimposing electrical energy on the flame from a low-current, high-voltage, a-c discharge.

Need for Universal Checkout is Questioned

Martin study of predictable requirements of big weapon systems indicates that cost would make it impractical

by Charles D. LaFond

BALTIMORE—A Martin Co. study is tossing cold water on the need for a truly universal checkout system.

Looking over basic weapon parameters up through 1975 for the Air Force, the study finds few systems which would combine to make a universal checker practical.

Cost of a three-weapon checker in use, the study notes, would be more than double the total expenditure for three separate integrated, automatic and special-purpose checkout systems.

• **Studies unfunded**—In late 1960, the Air Force initiated four unfunded study projects for "Design Criteria for Automatic Test and Checkout Systems."

Martin's Electronics Division, Minneapolis-Honeywell, Nortronics Division of Northrop Corp., and a Motorola/Douglas team were selected to participate in the study. Each of the four studies was conducted independently, and the Air Force provided the participants with unusually broad need-to-know clearance.

Five primary objectives were sought in the seven-month studies:

1. To validate requirements for test and checkout across the spectrum for future weapon and space systems for a period ending in 1975. Air Force, Navy, Army and National Aeronautics and Space Administration systems—operational, R&D, and conceptual—were covered.

2. To corroborate design criteria which would assure compatibility of all future weapon systems, checkout, and associated test equipment.

3. To determine feasibility of standardizing components and techniques in test and checkout systems.

4. To determine feasibility of designing an integrated, multipurpose, automatic test and checkout system or family of systems.

5. To analyze cost versus increased weapon system effectiveness in support of any conclusions and recommendations resulting from each study.

• **Martin approach**—In its approach to the checkout study, Martin employed nine separate teams of engineers drawn from its divisions in Baltimore, Denver, Orlando, and Cocoa. The whole group was under the direction of W. O. Campbell of the company's GSE Department, Electronics Division, in Baltimore.

During the course of the study, Campbell said, he and his teams interviewed hundreds of specialists in all of the military services, NASA, and various laboratories throughout the country. In addition, they surveyed over 20 technical publications for pertinent data.

Only major conceptual weapons systems were considered, because of their inherent diversity and complexity. Campbell, for his investigations, chose nine representative systems: two manned space vehicles, five missiles and two aircraft. He described these as:

—A manned space platform (similar to *Apollo*).

—A *Dyna-Soar X*, described as an advanced follow-on type from the current AF program.

—Two super ICBM's, one mobile and one for a fixed hardened base (advanced versions of *Atlas, Titan, Minuteman*).

—A tactical ballistic missile such as *Pershing*.

—A *Nike-Zeus*-type AICBM.

—A *Skybolt*-type ALBM.

—A B-70 follow-on vehicle.

—And finally, a V/STOL (vertical or short takeoff and landing aircraft). One study team was assigned to each system.

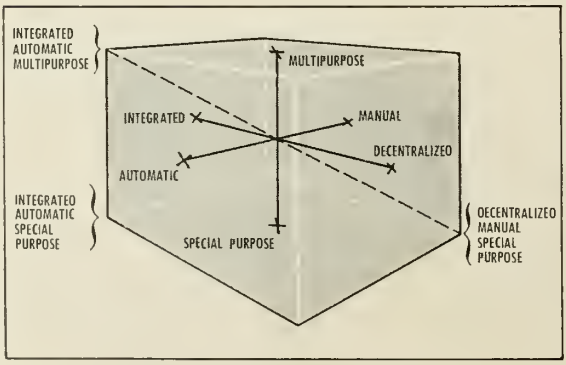
• **The Golden Cube**—As a result of its study, Martin-Electronics believes it has originated a unique management tool for use in selecting the correct checkout concept for any given weapon system. Called the "Golden Cube," it is based on a three-dimensional graphic approach for relating key weapon system/checkout parameters.

During the course of the study, a general checkout model was deduced by members of the group by reducing all known system configurations to three basic parameters: 1. degree of automaticity; 2. degree of checkout capability (from special purpose to multipurpose); and 3. degree of integration. Since these were considered mutually independent checkout ideas, they could be plotted on an X-Y-Z diagram.

Also, it was determined that all known weapon-system checkout situations could be reduced to three parameters: 1. workload requirement; 2. degree of weapon-system design firmness and 3. degree of integration of subsystems within the weapon system. Most significant, however, was the fact that these parameters too were mutually independent and they co-related one-to-one with the three checkout parameters.

Once these fundamental concepts

(Continued on page 31)



"GOLDEN CUBE" developed by Martin-Electronics in study of future Air Force checkout needs. The three basic parameters can be weighted, Martin says, and by three-dimensional plotting, a precise model of the required system configuration can be deduced.






JULY, 1961

MISSILES and ROCKETS

ASTROLOG

Current status of U. S. missile and space programs plus all orbiting satellites



Satellites and Spacecraft

PROJECT	CONTRACTORS	DESCRIPTION	STATUS
★**ADVENT** (Army)	Army Signal Carps, prime; Bendix prime far 24-haur satellite cammunicatians package; GE, vehicle	Twenty-faur haur instantaneaus repeater cammunicatians satellite; mare than 1250 lbs.; pragram incarparates Prajects STEER, DECREE and COURIER	R&D; graund sites ta be equipped at Ft. Dix, N.J., and Camp Raberts, Calif.; shipbaard terminals alsa being designed; first ATLAS-CENTAUR launchings late '62; may use TITAN II space baaster
ANNA (Army, Navy, AF, NASA)	Na cantractars annaunced	Geadetic satellite; 50-100 lbs.; prabably spherical	Study completed; R&D pragram appears imminent
AEROS (NASA)	Na cantract annaunced	24-hour weather satellite ta be baasted by CENTAUR	Planning. First flights wauld be in 1964 ar 1965; unfunded FY '62 budget; TV camera R&D ta begin saan
★**APOLLO** (NASA)	Canvair, Martin, GE	Three-man spacecraft capable af arbiting maan ar becaming space statian; prabably winged far lunar flights; boosted by SATURN	Studies completed; pragram greatly accelerated; cantractar briefings midsummer
ARENTS (ARPA)	Canvair, prime	Satellites ta investigate deep space; 22,000 m. arbits; ATLAS-CENTAUR booster	Cantract let ta build three paylaads; launchings begin early '62
ASP (Air Farce)	Na cantracts annaunced	Aeraspace plane, a manned spacecraft capable af aperating in the atmasphere and space	Study
BAMBI (ARPA)	Canvair, STL	Satellite system capable af intercepting enemy missiles in baast phase	Studies
CSAR (Air Farce)	Na cantracts announced	Cammunicatians satellite system; satellites ta weigh passibly twa tans; ta use passive lens reflectars	Studies; passibly aperatianal mid-60's
★**DISCOVERER** (Air Farce)	Lackheed, prime; GE, re-entry vehicle	THOR-AGENA and ATLAS-AGENA launchings af early stabilized satellites; main purpase is ta test techniques far military space systems	Launchings: 25; 6 capsules recavered fram arbit (3 air-snatched); after arbiting earth one ta three days; plans ta put simians in capsules delayed
★**DYNA-SOAR I** (Air Farce)	Baeing, spacecraft and systems integrator; Martin, prapulsion; Minneapalis-Haneywell, guidance; RCA, cammunicatians data link	Baast-glide arbital spacecraft; R&D leading ta first space bamber; TITAN II baaster; 3rd pawered stage ta be added	R&D; first glider flights fram Edwards AFB 1962; R&D subarbital flight abaut early 1965; pragram accelerated samewhat under FY '62 budget
ECHO (NASA)	Langley Research Center, prime	ECHO I: 100 ft. inflatable sphere in 1000 mile arbit; passive cammunicatian satellite; ECHO II: 135-ft., 700-mi. arbit	In arbit since Aug. 12, 1960; ECHO II scheduled ta be launched 1962; subarbital tests late '61

★ Indicates change since May 1961 Astrolog

PROJECT	CONTRACTORS	DESCRIPTION	STATUS
MARINER (NASA)	JPL, prime	600-1200 lb. unmanned spacecraft for early interplanetary missions; boosted by ATLAS-AGENA B	Seven shats planned. First scheduled Venus fly-by Aug. 1962
★**MERCURY** (NASA)	McDonnell, capsule	First U.S. manned satellite; 2500 lb. capsule; ATLAS boasted	First manned orbit shot expected late 1961 or early 1962. First manned sub-orbital launching with REDSTONE May 5
MIDAS (Air Force)	Lackheed, prime; Aerojet, IR detectar system	Early-warning satellite; detect ICBM launchings by infrared before birds leave pod; R&D models weigh 2.5 tons; operational system ta have 12-15 satellites	R&D; second launching May 24, 1960 partial success; components being tested by DISCOVERER
NIMBUS (NASA)	GE, prime	2nd generation weather satellite; 650 lbs.; 6 TV cameras in payload; THOR-AGENA B booster	First launching scheduled far late 1962
OAO (NASA)	Grumman, prime; Westinghouse, electranic components; GE, stabilizatian and control	3500-lb. orbiting astronomical satellite observatary equipped with telescape; baasted by ATLAS-AGENA B	First flight scheduled in late 1963 or 1964
OGO (NASA)	Space Technology Labaratories, prime	1000-lb. satellites with instruments for geophysical measurements; polar (POGO) and eccentric (EGO) shots planned; ATLAS-AGENA B, THOR-AGENA B, CENTAUR baasters	First flight scheduled in 1963
OSO (NASA)	Ball Brathers, prime	350-lb. orbiting solar observatory; THOR-DELTA booster	First flight planned summer 1961
PROSPECTOR (NASA)	No contract annaunced	Soft-landed, remate contral, unmanned maan explaring spacecroft; SATURN booster	First flight planned by 1965; study contracts to be awarded in 1961
RANGER (NASA)	JPL, prime; Aeronutronic, capsule; Hercules, retraracket	300-lb. instrumented capsule raugh landed on moan; ATLAS-AGENA B baaster	R&D; first flight planned 1961; first lunar landing planned for 1962, instrumentation to include seismometer.
REBOUND (NASA)	No contract annaunced	System of 3 to 6 multi-launched ECHO II communications satellites	First orbital flight scheduled for 1963 or 1964
★**RELAY** (NASA)	RCA, prime	100-lb. active repeater communicotions satellites. Cammerciol system planned; DELTA launched	Both Britain and France to take part in progrom; Latin American interest sought
SAINT (Air Force)	RCA, prime	Anti-satellite satellite inspectian system; to be complemented by interception system; obout 2 tons; ATLAS launched	R&D underway; to be launched againsf reflectars or ballaons in 400-mi. orbits late '61
SAMOS (Air Farce)	Lockheed, prime	Reconnaissance satellite; formerly SENTRY; R&D model weighs 4100 lbs.	R&D; SAMOS II successfully launched Jan. 31 from Vandenberg. First lounch foiled to put SAMOS in orbit Oct. 11; scheduled to be operational late 1962, eorly 1963 under new, bigger program; components being tested in DISCOVERERS
SLOMAR (Air Force)	Lackheed and Martin, prime	Lagistics, maintenance, supply spacecraft for space systems	Study contracts awarded in December
SURVEYOR (NASA)	Hughes, prime	750-lb. spacecraft saft-landing 100-300 lbs. instruments on moon; ATLAS-CENTAUR booster	First moon flights 1963; seven to be launched by 1965
TIROS (NASA-AF-Army-Novy-Weo. Bu.)	RCA-Army Signal Carps, prime	Meteorological satellite; TV pictures of cloud cover; TIROS II carried IR scanner	R&D; first launching lost April; second Nov. 23, bath successful. At leost one more planned
TRANSIT (Navy)	Applied Physics Laboratory, prime	Navigational satellite; R&D model weighs more than 250 lbs.; operotionol model about 50-100 lbs.	TRANSIT IB R&D satellite in orbit April 13; 11A plus piggyback satellite in orbit June 22; TRANSIT IIIB lounched inta poor orbit Feb. 21; four-satellite system scheduled to be in orbit 1962
VOYAGER (NASA)	No contract annaunced	Unmanned spacecraft to orbit Mars or Venus; eject capsule for re-entry; SATURN booster	Study; first flight planned by 1965
YO YO (Navy)	Na contract annaunced	Tactical sea-launched one-pass reconnaissance satelloid	R&D
★**X-15** (NASA-AF-Navy)	Narth American, prime; Thiokol, propulsion	Rocket plone; 4000 mph; flight at edge of space; on AF model each XLR-11 racket engine develops 16,000 lbs. of thrust; XLR-99 engines 50,000 lbs. Three planes delivered.	Powered flights in progress; plane #1 hos hit Mach 3 and more than 136,500 ft. with XLR-11 engine; plane #2 with XLR-99 engine turned over to NASA, has hit 3690 mph speed record; altitude record of 169,600 ft. (unofficio for manned, powered flight)



Missiles and Rockets

PROJECT	CONTRACTORS	DESCRIPTION	STATUS
ALFA (Novy)	Novy, prime; Avco, air frame	ASW surface-to-underwater; 500 lb. solid; conventional	Deployed on destroyer escorts
ARM (Novy)	No contract announced	Anti-radar missile; air to surface	R&D; AF anti-rador missile by same name at least temporarily shelved
ASROC (Novy)	Minneopolis-Honeywell, prime; Sangamo Electric, sonor; torpedo, GE; depth charge, M-H	Surface-to-underwater; solid rocket torpedo or depth charge; nuclear or conventional, range obout 8 miles; advanced ASROC (improved Mark 44 torpedo) under R&D	R&D; operotionol on Destroyers Norfolk, Adams, Dewey and Perry; plans call for deploying on 150 destroyers and cruisers
ASTOR (Navy)	Westinghouse, prime	ASW underwoter to underwater rocket torpedo; nuclear	R&D
ATLAS (Air Force)	Convair, prime; GE/Burroughs, Arma, guidonce; Rocketdyne, propulsion; GE/Avco, re-entry vehicle	ICBM; more than 5500-to-7500 mile range; liquid; nuclear; ATLAS "E" series has inertial guidance; earlier ATLAS "D" has radio inertial; proposed ATLAS "G" would have 900,000-lb. thrust and 4000-lb. payload capability	86 launchings; 56 successes, 20 partiol, 10 follures; 11 boses for 13 squodrons; operotional at Vandenberg and Warren; ATLAS E tests began Oct. 11; about 18 to 21 launchers operationol—40 to 60 expected in 1961. First successful "E" shot Feb. 24
BOMARC-A (Air Force)	Boeing, prime; IBM/Westinghouse, guidonce; Aerojet/Marquardt, propulsion	Ramjet surface-to-air interceptor; liquid booster; 250 m. range; Mach 2.7; nuclear	Five bases operationol in Northeostern U.S. from Virginia to Maine
BOMARC-B (Air Force)	Boeing, prime; Kearfott/Westinghouse, IBM Guidance; Thiokol/Marquardt, propulsion	Ramjet, surface-to-air; solid booster; Mach 2.7; more than 400 m. range; nuclear	B models being produced; a B test bird intercepted simulated target 345 miles away Oct. 14; to be deployed at 6 U.S. bases, two in Conada
BULLPUP (Navy-Air Force)	Martin, prime; Martin, guidance; Thiokol, Naval Propellant Plant, propulsion; Maxson, second-source prime	Air-to-surface; 3-6 mile range; conventional 250-1000-lb. bomb; new model has pre-packaged liquid; nuclear-tipped model nearly operational; AF designation: GAM 83-A (HE warhead), GAM 83-B (nuclear)	Deployed with Atlantic and Pacific Fleets; bigger model under R&D; soon operational with Air Force units. Marines launching BULLPUP from helicopters
COBRA (Navy)	No contract announced	Anti-ship radar missile	Early R&D
COBRA (Marines)	Boelkow Entwicklungen, West Germany, prime manufocturer; Daystrom, U.S. licensee	20.2-pound onti-tank missile; 1 mile range; 191 mph speed; solid propellant	Morines planning to purchase; Army considering them; already operational with West German troops
CORPORAL (Army)	Firestone, prime; Gilfillan, guidance; Ryon, propulsion	Surface - to - surface; 75-mile range; liquid; nuclear	Deployed with U.S. & NATO troops in Europe
CROW (Navy)	No contract onnounced	Air-to-air missile	R&D; has been flight tested
DAVY CROCKETT (Army)	In-house project directed by Rock Island, Ill., arsenal	Surface - to - surface; solid; bazooka launched; sub-kiloton nuclear warheod; two launchers of different size for various ranges; vehicle mounted or carried by two men	Lote R&D; deployment delayed until 1962
ENTAC (Army)	Nord Aviation, prime	Anti-tank; 6600-ft. range; 37 lbs.; HE warhead; wire-guided.	Operational; Army buying from French in quantity
FABMIDS (Army)	Convair, Hughes, Martin, GE, Raytheon, Sylvania—feasibility studies	Mobile anti-missile defense system	Eoch of six contractors have $250,000 feasibility study contracts owarded Oct. 10; reports expected mid-'61
FALCON (Air Force)	Hughes, prime; Hughes, guidance; Thiokol, propulsion	Air-to-air; 5-mile range; Mach 2; solid; conventional; GAR-11 has nuclear warhead	GAR-1 through GAR-4 operational; GAR-9 R&D; GAR-11 operational in near future; buy-out of GAR 3A, 4A and 11 in FY '62
GENIE (Air Force)	Douglas, prime; Aerojet-Generol, propulsion	Air-to-air unguided; 1.5-mile range; nuclear	Operational
GIMLET (Navy)	No contract announced	Air-to-surfoce; unguided; considered highly accurate	R&D
HAWK (Army)	Raytheon, prime; Raytheon, guidance; Aerojet-General, propulsion	Surface-to-air; 22-mile range; solid; conventional; designed to hit low-flying planes	Operationol; deployed at Panama, Okinawa; SUPER HAWK under development; Jan. 29, 1960 successfully intercepted HONEST JOHN, first known missile intercept of another

PROJECT	CONTRACTORS	DESCRIPTION	STATUS
HONEST JOHN (Army)	Douglas/Emerson Electric, prime; Hercules, propulsion	Surface-to-surface; unguided; 12-mile range; nuclear	Operational; deployed in Europe
HOUND DOG (Air Force)	North American, prime; Autonetics, guidance; Pratt and Whitney, propulsion	Air breathing air-to-surface; 500-mile range; Mach 1.7; turbojet; nuclear	Operational; to be launched from B-52G intercontinental bombers; stockpile expected to exceed 400
JUPITER (Army)	Chrysler, prime; Ford Instrument, guidance; Rocketdyne, propulsion; Goodyear/CTL, re-entry vehicle	IRBM; liquid; nuclear; can be made mobile	To be deployed with Italian and Turkish troops. 31 military launchings: 24 successes; 5 partials; 2 failures. Full tactical GSE used for first time in Oct. 20 shot from Cape
LACROSSE (Army)	Mortin, prime; Martin, guidonce; Thiokol, propulsion	Surfoce-to-surface; highly mobile; 20-mile range; solid; nuclear	Operational; three units deployed in Europe; more being trained; advanced LACROSSE R&D dropped
LAW (Army)	Hesse-Eastern Div., Flightex Fobrics, prime	Light onti-tank rocket; carrier tube launcher; 4.5 lbs.; 25 in. long/3 in. diameter	R&D under AOMC
LITTLE JOHN (Army)	Emerson Electric, prime; Hercules Powder, propulsion	Surface-to-surface; unguided; 10-mile range; solid; nuclear	First 4-launcher battalion operotional this winter
LOBBER (Army)	No contract announced	Surface-to-surface; cargo carrier; 10-15 mile range; olso can drop napalm; LOBBER with worheod called BALLISTA	Studies
LULU (Navy)	General Mills/Noval Ordnance Lab, prime	Small nuclear depth charge oir-dropped or launched by ASROC	Operotional
★**MACE** (Air Force)	Martin, prime; Goodyear/AC Spork Plug, guidance; Thiokol/Allison, propulsion	Air-breathing surface-to-surface; more thon 650-mile ronge; turbojet & solid-nuclear; B model has more than 1200 mile range	Being deployed with U.S. troops in West Germany; now oll mobile but hord-base version development completed; to be in Okinawa, Koreo
MATADOR (Air Force)	Martin, prime; Thiokol/Allison, propulsion	Air-breothing surface-to-surfoce; 650 mile range	Being turned over to West Germans; also deployed in For East
MAULER (Army)	Convair, prime	Surface-to-air; radar guidance; highly mobile antiaircroft and antimissile missile for field use; on trocked vehicle; 12 missiles per launcher	R&D; NATO may buy
★**MINUTEMAN** (Air Force)	Boeing, major contractor; Autonetics, guidance; Thiokol, propulsion first stage; Aerojet, propulsion second stage; Hercules, third stage; Avco, re-entry vehicle; AMF-ACF, rail launcher	2nd generation ICBM; solid; fixed or mobile aboard railroad trains; nuclear; 3 stages	R&D; scheduled to be operational mid-1962 at Malmstrom AFB; first R&D flight (all stages igniting) from Cape Feb. 1 a success; 2nd lounching May 19 a partial success; tactical rail system tests completed; 3 squadrons at Malstrom, Mont.; Ellsworth, S. D.; Whitman, Mo.; Minot, N. D. 12 fixed squadrons now planned; mobile system indefinitely postponed
M-SS (Army)	Norris Thermador, prime	Four-inch diameter, small, short-range poison gas rockets; to be fired from 45-tube launchers	Operational
MISSILE A (Army)	ARGMA, prime	Surface-to-surface; 10-20 mile ronge; solid	Design studies
NIKE-AJAX (Army)	Western Electric, prime; Western Electric, guidance; Thiokol, propulsion; Douglas, airframe	Surface-to-air; 25-mile range; Mach 2.5; solid & liquid; conventional	Deployed in U.S., Europe & Far East; about 170 batteries in U.S., sixty-eight more to be phased out and replaced with NIKE-HERCULES
NIKE-HERCULES (Army)	Western Electric, prime; Western Electric, guidance; Hercules & Thiokol, propulsion; Douglas, airframe	Surface-to-air; 75-mile range; Mach 3+; nucleor; onti-oircraft, tactical missiles; mobile or fixed	Rapidly replacing NIKE-AJAX; well over 80 batteries deployed in U.S.; more than 10 N-H batteries being deployed overseas in 1961; N-H on Formosa
NIKE-ZEUS (Army)	Western Electric, prime; Bell Telephone, guidance; Thiokol/Grand Central, propulsion; Douglas, airframe	Anti-missile; 3-stage; 200-mile range; solid; nuclear	R&D test launchings ot White Sands 14 R&D launchings; 8 successful, 4 partial, 2 failures. Complete system tests now scheduled for early '62
★**PERSHING** (Army)	Martin, prime; Bendix, guidonce, Thiokol, propulsion	Surface-to-surface; two-stage solid; approx. 500-mile range; nuclear; transported on FMC XM474 tracked vehicle; proposed PERSHING II would have 1000-mile range	R&D; to replace REDSTONE; 17 R&D launchings: 14 successes (both stages launched, guidance carried os passenger Dec. 12 for first time), 3 foilures Operational lote 1961; R&D launching about 250 miles April 21

PROJECT	CONTRACTORS	DESCRIPTION	STATUS
★**POLARIS** (Navy)	Lockheed, prime; GE/MIT, guidance and fire control; Aerojet-General, propulsian; Lockheed, re-entry vehicle	Underwater and surface-to-surface; solid; 1200-mile range can hit more than 90% all targets in Russia; nuclear; POLARIS II (1500-mile range) and SUPER POLARIS (2500 mile range) under R&D	98 launchings of test vehicles; 65 successes; 22 partial; 5 failures; 25 also launched from submerged subs—all cleared surface; 17 successful flights, 8 failures. Two subs each with 16 missiles operational, 3rd deploying this spring. Total authorized by White House: 29. POLARISES for cruiser Long 8each cancelled; Polaris II R&D missiles impacting 1400+ n.mi. in guided flight
QUAIL (Air Force)	McDonnell, prime; Summers Gyro, guidance; GE, propulsion; Ramo-Wooldridge, ECM equipment	ECM-carrying bomber decoy; about 200 m. range; jet powered	Deployed at SAC bases; carried by B-52
RAVEN (Navy)	No contract announced	Air-to-surface; about 500-mile range	Study
★**REDEYE** (Army)	Canvair, prime; Philca/Convair Atlantic Research, propulsion	Surface-to-air; 4-foot, 20-lb. bazooka-type; IR guidance; salid; conventional; container-launcher disposable	Late R&D; deployment delayed until late 1962; Marines also will use; NATO may buy
REDSTONE (Army)	Chrysler, prime; Ford Instrument, guidance; Rocketdyne, propulsion	Surface-to-surface; liquid; 200-mile range; nuclear	Deployed with U.S. troops in Europe; to be replaced by PERSHING
REGULUS I (Navy)	Chance Vought, prime and guidance; Aerojet-General, propulsion	Surface-to-surface; turbojet & solid; 500-mile range; nuclear	Deployed aboard U.S. submarines; REGULUS II used as target drone
SEMPER (Marines)	No contracts announced	8elieved to be an air-launched missile	R&D testing at Pt. Mugu
SERGEANT (Army)	Sperry, prime; Sperry, guidance; Thiokal, propulsian	Surface-to-surface; salid; more than 75-mile range; nuclear	In production
SHILLELAGH (Army)	Aeronutronic, prime	Surface-to-surface; lightweight; can be vehicle-mounted	Early R&D
SIDEWINDER (Navy-Air Force)	GE-Philco, prime; Philco/GE guidance; Naval Powder Plant, propulsion	Air-to-air; IR guidance; more than 2 m. range; conventional; new I-C models to have switchable IR and radar-guided warheads	Deployed with Navy and Air Force; all-weather type under development
SKYBOLT (Air Force)	Douglas, prime; Nortronics, guidance; Aerojet, propulsion; GE, re-entry vehicle	ALBM; more than 1000-mile range; solid; nuclear; to be launched from B-52, B-70 and Vulcan bombers	R&D; to be purchased by British; operational 1964; test-launching to be from Eglin AFB, Fla. Add. funding restores old operational date
SLAM (Air Force)	No contract announced	Surface-to-surface; low-altitude; supersonic; nuclear ramjet and warhead	Study-R&D
★**SNARK** (Air Farce)	Narair, prime; Northrop, guidance; Pratt & Whitney/ABL, propulsion	Surface-to-surface; 5500-mile range; salid and turbojet; Mach .9; nuclear	One squadron of 30 missiles at Presque Isle, Maine; being disbanded
SPARROW III (Navy)	Raytheon, prime; Raytheon, guidance; Aerojet-General, Thiokol propulsion	Air-to-air; 5-8 mile range; Mach 2.5-3; solid and pre-packaged liquid; conventional	Operational with carrier aircraft earlier SPARROW I obsolete; new contract extending range, altitude
SUBROC (Navy)	Goodyear, prime; Kearfott, guidance; Thiokal, prapulsion	Underwater or surface-to-underwater; 25-30 mile range; solid; nuclear	Estimated operational date: 1961. To be installed first on Thresher nuclear-powered attack submarine
SS-10 (Army)	Nord Aviation, prime; GE, U.S. licensee	Surface-to-surface; primarily antitank; 1600-yards range; 33 lbs. solid; wire guided; conventional	Operational with U.S., French and other NATO and Western units; battle-tested in North Africa
SS-11 (Army)	Nord Aviation, prime; G.E., U.S. licensee	Surface-to-surface; also helicopter-to-surface; 3800-yard range; 63 lbs; wire guided; conventional	Operational. Under evaluation by Army; decision on procurement due far some time
TALOS (Navy)	Bendix, prime; Bendix/Sperry, guidance; Naval Propellant Plant, propulsion	Surface-to-surface; 65-mile range; solid & ramjet; Mach 2.5; nuclear	Operational aboard cruiser Galveston
TARTAR (Navy)	Convair, prime; Raytheon, guidance; Aerojet-General, propulsion	Surface-to-air; 10-mile range; Mach 2; 15 feet long & 1 foot in diameter; solid dual-thrust motar; conventional	Operational on Missile Destrayer Adams in Oct.
TERNE (Navy)	Kongsberg Vapenfabrikk, prime; Arma, systems integration	Surface-to-underwater ASW missile; 264 lbs; HE warhead	Navy buying fram Norway to equip twa destroyer escorts
TERRIER (Navy)	Convair, prime; Reeves/FTL, Sperry guidance; ABL, propulsion	Surface-ta-air; 10-mile range; Mach 2.5; 27 feet long; solid conventional	Operational with fleet
TERRIER-ADVANCED (Navy)	Convair, prime; Reeves/FTL, Sperry guidance; ABL, propulsion	About 100% performance improvement over TERRIER	Operatianal with fleet; being deployed on destroyers and carriers
★**THOR** (Air Force)	Douglas, prime; AC Spark Plug, guidance; Rocketdyne, propulsion; GE re-entry vehicle	Surface-to-surface IRBM; 1500-mile range; liquid; nuclear	Operational; 4 bases set up in England. 66 military launchings: 45 successes; 11 partial; 10 failures. 49 scientific launchings: 41 successful, 2 partial; 6 failures

PROJECT	CONTRACTORS	DESCRIPTION	STATUS
★**TITAN** (Air Force)	Martin, prime; Bell/Sperry, TITAN I guidance; AC Spark Plug, TITAN II guidance; Aerojet-Generol, propulsion; Avco, TITAN I re-entry vehicle; GE, TITAN II re-entry vehicle	Surface-to-surface ICBM; 5500-mile range; liquid; 90 feet long; nucleor; TITAN I burns LOX-Kerosene; TITAN II has storable propellants, inertial guidance, bigger poylaad, greoter ronge, 115 ft. long TITAN III proposed	34 launchings test vehicles: 23 successes; 7 portial; 4 failures. 8 bases for 12 squadrons plonned; TITAN I scheduled to be operational mid-1961; TITAN II scheduled operationol early 1963; first silo launch was scheduled in May; first TITAN II in Nav.
TYPHON (Navy)	Westinghouse, prime; Bendix propulsian	Medium and long range seagoing anti-missile missiles; formerly colled SUPER TARTAR and SUPER TALOS; solid booster and ramjet sustainer; conventional; supersonic	Early R&D; may be used on hydrofoil destroyers
★**WAGTAIL** (Air Force)	Minneopolis-Honeywell, prime	Fomily of airborne RLM's (rear-launched missiles): air-ta-air and air-to-surfoce	Late R&D
WILLOW (Army)	Chrysler, prime	Highly-classified missile	R&D
ZUNI (Navy)	Naval Ordnance Test Station, prime Hunter-Douglas, propulsion	Air-to-air, air-to-surface; solid; unguided; 5-m. range; conventional	Operationol



Space Vehicles

AGENA (Air Force)	Lackheed, prime; Bell, propulsion	1700-pound satellite ofter burnout; AGENA B stop-stort 2450-lb. engine; about double fuel capacity of AGENA A	Used in DISCOVERER program; larger AGENA B olso to be used with ATLAS and THOR
BLUE SCOUT (Air Farce)	Aeronutranic, prime; Minneapolis-Honeywell, guidance; Aerajet/Hercules, Thiokol, propulsion	Solid multi-stage booster based on SCOUT camponents	Launchings 3: 2 successes; 1 partial
CENTAUR (NASA)	Convair, prime; Pratt & Whitney, propulsion; Minneapolis-Honeywell, guidance	Pair of LOX-liquid hydragen engines; 30,000 lbs. total thrust, otop ATLAS booster, capoble orbiting 8500 lbs. launching 1450-lb. space probe.	First test flight in 1961; first engine delivered
DELTA (NASA)	Douglas, booster; Bell, guidance; Rocketdyne/Aerojet/ABL, propulsion	Successor ta THOR-ABLE; upper stage guidance; 480 lb. paylood capacity	Interim launch vehicle far TIROS-ECHO; being used for other satellites and one deep spoce probe
JUNO II (NASA)	Marshall Center/Chrysler, prime; Ford Instrument, guid.; Rocketdyne/JPL, propulsion	Early deep space booster; small paylaad	Phasing out
★**NOVA-L** (NASA)	No prime announced; Racketdyne, propulsion	Clustered 6-12 million lb. liquid propellant booster plus upper stages	R&D on 1.5 millian lb. F-1 engines; vehicle contract expected to be awarded this fall
★**NOVA-S** (Air Farce)	No contractor announced; expected to be based an Aerojet/Grand Central feasibility studies	Clustered 12-million lb. baoster; possible alternative ta Nova-L	R&D; cantracts expected to be let quickly
ORION (Air Force)	General Atamic	Space boaster launched by series of atamic explosions	Advanced engineering studies under way; tests may be attempted
PHOENIX (Air Force)	No cantracts announced	Recaverable booster—possibly a madified F-1	Studies
ROVER (NASA, AEC)	No prime announced	First nuclear rocket: KIWI non-flying test engines and NERVA flight engines	Contracts to be let this year
SATURN (NASA)	Marshall Center, prime and booster; Douglas and Convair, upper stages; Rocketdyne, booster and mid-stage engines; Pratt & Whitney, top-stage engines	Series of multistage vehicles bosed on 1.5-million-lb. clustered boaster and various upper stages of LOX-liquid hydragen engines. Early model to orbit 20,000-lb. payload	Second static tests ended; flight booster to be static-tested this spring far summer flight; flight with live upper stages scheduled 1963
SCOUT (NASA)	Chance Vaught, prime; Minneapalis-Honeywell, guidonce; Aerojet-Generol/Hercules/Thiokol/ABL, prapulsion	Solid faur-stage satellite launcher; 200 lb. payload in orbit	SCOUT 4 launched. EXPLORER IX Feb. 16. Four more SCOUT flights in '61 completes R&D; Navy proposing SEA-SCOUT for seaborne surface launch, wauld be based an POLARIS and SCOUT
THOR-ABLESTAR (Air Force-NASA)	STL, prime; Racketdyne/Aerojet-General/ABL, propulsian	Three-stage vehicle, orbital capability 800 lbs. Upper stage has restart engine	THOR-ABLE phased out. THOR-ABLESTAR aperational in TRANSIT and COURIER



Satellites in Orbit

★**EXPLORER I** (30.8 lbs.) U.S. Launched 1/31/58, est. life 7-10 years. Orbits earth; perigee 217 m., apogee 1120 m., period 106.6 min. (Discavered Van Allen Belt); nat transmitting.

★**VANGUARD I** (3.25 lbs.) U.S. Launched 3/17/58, est. life 200-1000 years. Orbits earth; perigee 404, apogee 2455, period 133.9; transmitting.

LUNIK I "MECHTA" (3245 lbs!) Russia, Launched 1/2/59. Believed ta be in arbit araund Sun an 15-ma. cycle; nat transmitting.

VANGUARD II (20.7 lbs.) U.S. Launched 2/17/59, est. life 100-250 years. Orbits earth but is "wabbling"; perigee 343, apogee 2052, period 125.4; inclinatian ta equatar 32.88°; nat transmitting.

PIONEER IV (13.4 lbs.) U.S. Launched 3/3/59. Orbits Sun, and achieved primary missian—earth-maan trajectary; nat transmitting.

EXPLORER VI "PADDLEWHEEL" (142 lbs.) U.S. Launched 8/7/59, est. life ta Aug., 1961. Orbits earth; initial perigee 156, initial apagee 26,357, initial period 12½ hrs. present arbit uncertain.

★**VANGUARD III** (abaut 100 lbs.) U.S. Launched 9/18/59, est. life 50-150 years. Orbits earth; perigee 322, apagee 2318, period 129.8; nat transmitting.

★**EXPLORER VII** (91.5 lbs.) U.S. Launched 10/13/59, est. life 30-40 years. Orbits earth; perigee 344, apagee 669, period 101.1; transmitting.

PIONEER V (94.8 lbs.) U.S. Launched 3/11/60, est. life farever. Orbits Sun, interplanetary enviranment prabe; completed ane full arbit 1/16/61; aphelian .9931 au, perihelian .8061 au; nat transmitting.

★**TIROS I** (270 lbs.) U.S. Launched 4/1/60, est. life 50-150 years. Orbits earth; picture-taking weather satellite; perigee 429, apagee 467, period 99.1; transmitting.

★**TRANSIT IB** (265 lbs.) U.S. Launched 4/13/60, est. life 6 years. Orbits earth; perigee 229, apagee 417, period 95.0. First R&D navigatian satellite. Nat transmitting.

★**SPUTNIK IV** (10,008 lbs.) Russia. Launched 5/15/60, est. life 2-3 years. Orbits earth; initial perigee 188, apagee 229—changed ta 191/429 an 5/19/60; last reparted—perigee 175, apagee 322, period 92.6. Test af suppart systems, cabin, far manned space flight; attempt ta return fram arbit failed; paylaad, case and twa pieces naw in arbit. Nat transmitting.

★**MIDAS II** (5000 lbs.) U.S. Launched 5/24/60, est. life 8-15 years. Orbits earth; perigee 297, apagee 315, period 94.3 Telemetry far IR scanning failed twa days after launch. Transmitting.

★**TRANSIT II-A** (223 lbs.) U.S. Launched 6/22/60, est. life 50-200 years. Orbits earth, perigee 389, apagee 649, period 101.6. Transmitting.

NRL SOLAR RADIATION SATELLITE I (40 lbs.) U.S. Launched 6/22/60 with TRANSIT II-A, est. life 50-200 years. Orbits earth; perigee 381, apagee 657, period 101.6. Nat transmitting.

★**ECHO I** (132 lbs.) U.S. Launched 8/12/60, est. life 2-16 years. Orbits earth; perigee 934, apagee 994, period 117.0. First successful arbiting af passive communicatians satellite.

COURIER IB (500 lbs.) U.S. Launched 10/4/60, est. life 200-500 years. Orbits earth; perigee 604, apagee 750, period 106.9. First successful launching af delayed active repeater satellite. Transmitting.

★**EXPLORER VIII** (90 lbs.) U.S. Launched 11/3/60 by JUNO II, est. life 20-50 years. Orbits earth, perigee 262, apagee 1412, period 112.6. Pravides ianaspheric measurements far cammunicatians. Nat transmitting.

★**TIROS II** (280 lbs.) U.S. Launched 11/23/60, est. life 200-500 years. Orbits earth; perigee 378, apagee 461, period 98.2. Transmitting.

★**SAMOS II** (4100 lbs.) U.S. Launched 1/31/61. Orbits earth; perigee 295, apagee 342, period 94.9. First R&D recannaissance satellite.

★**VENUS PROBE** (1419 lbs.) Russia. Launched 2/12/61, aphelian 1.684 au, perihelian 0.7104 au.

★**EXPLORER IX** (15 lbs.) U.S. Launched 2/16/61. Orbits earth; perigee 430, apagee 1580, period 118.2 A 12-ft. "palka dat" ballaan.

★**DISCOVERER XX** (2450 lbs.) U.S. Launched 2/17/61. Orbits earth; perigee 176, apagee 440, period 94.7. No attempt ta recover 300-lb. capsule because af malfunctian.

★**DISCOVERER XXI** (2100 lbs.) U.S. Launched 2/18/61. Orbits earth; perigee 154, apogee 572, period 96.6. Carried IR equipment far MIDAS pragram ta measure backgraund radiation from earth.

★**EXPLORER X** (78 lbs.) U.S. Launched 3/25/61. Last knawn positian: perigee 110, apagee 112,500, period 5012. Optical-pumping magnetameter. Pasitian uncertain.

★**DISCOVERER XXIII** (2100 lbs.) U.S. Launched 4/8/61. Orbits earth; perigee 183, apagee 372, period 93.6. Capsule ejected in wrang directian, sending it further into space. Transmitting.

★**EXPLORER XI** (82 lbs.) U.S. Launched 4/27/61. Orbits earth; perigee 302, apagee 1107, period 107.9. Measures gamma rays fram the stars absarbed in earth's atmosphere.

★**DISCOVERER XXV** (2100 lbs.) U.S. Launched 6/16/61. Orbits earth; perigee 139, apagee 250, period 90.8. Carried rare and camman metals ta study effects of space an them.

(Orbital data is latest official information as of 1200 Z, June 20, 1961)

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(Continued from page 22)

were determined, said Campbell, it was only necessary to weight each parameter, plot it, and thus describe a conceptual approach to the necessary checkout system. Martin feels that the technique holds true for any given weapon/checkout situation.

With this approach, the extremes would then be (for checkout parameters): from manual to fully automatic, from special-purpose to multipurpose, and from completely decentralized to fully integrated subsystems.

• **Use of the Cube**—The study group first selected what it believed to be the most promising of conceptual checkout approaches from the Golden Cube. These were the integrated automatic and decentralized automatic concepts—with the manual concept added as a check on the group's method of performing the study.

Each of the three concepts was employed by each team to generate 27 detailed hardware designs. These provided a means for evaluation and a plan which permitted comparison of results on a reasonable basis.

For the detailed designs, the same approach used on a missile project was employed. A team would start with mission requirements, work upward to maintenance and philosophy, and finally culminate in a detailed statement of the checkout task.

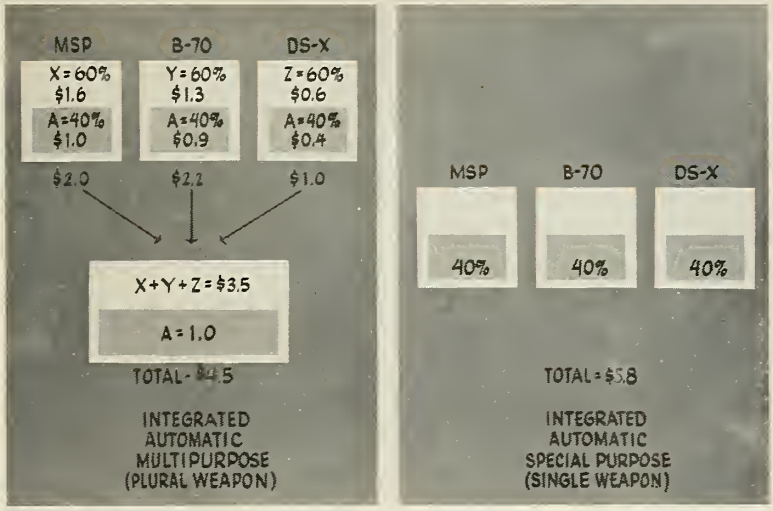
Checkout designs by each team were required to conform to four ground rules:

—To fulfill one of the three conceptual approaches;

—To perform the checkout properly;

—To be a reliable configuration; and

—To locate malfunctions to the level specified in each weapon-system maintenance philosophy.



COST COMPARISONS of multipurpose versus special-purpose integrated automatic checkout systems. Three hypothetical vehicles were considered: a manned space platform (MSP), a B-70 follow-on aircraft, and a Dyna-Soar follow-on (DS-X).

• **Degree of standardization**—In each case, the system configuration was left open as a degree of freedom. For example, there are 24 typical options in an integrated automatic system. It could have a computer and/or digital or analog blocks, multi- or special-purpose subsystems, single or multi-channel, and near or remote control (3x2x2x2 = 24 options).

Study results did indicate that standardization should be undertaken at the functional-chasis level. Also, additional provisional standards could be set for the module or printed-circuit-card levels if subjected to frequent updating.

The feasibility of standardizing major components was found to be 40% for digital and analog building blocks, but up to 70% for a computer-based approach. (Estimates were made by taking the ratio of versatile hardware to total hardware and averaging them over the various hardware designs.)

• **Universal checkout**—The true universal checkout system is at the integrated-automatic-multipurpose corner of Martin's Golden Cube. But the study indicated that it was doubtful whether the three co-relating weapon parameters would combine very often to require the concept.

The conditions necessary for a universal checker are a continuous, very high workload from diverse weapons randomly channeled through a single logistic area. Further, all such weapons must be completely integrated with respect to checkout.

To support its argument, the study group performed a cost comparison with three similar conceptual weapon systems—a manned space platform, a B-70 follow-on, and an advanced *Dyna-Soar*.

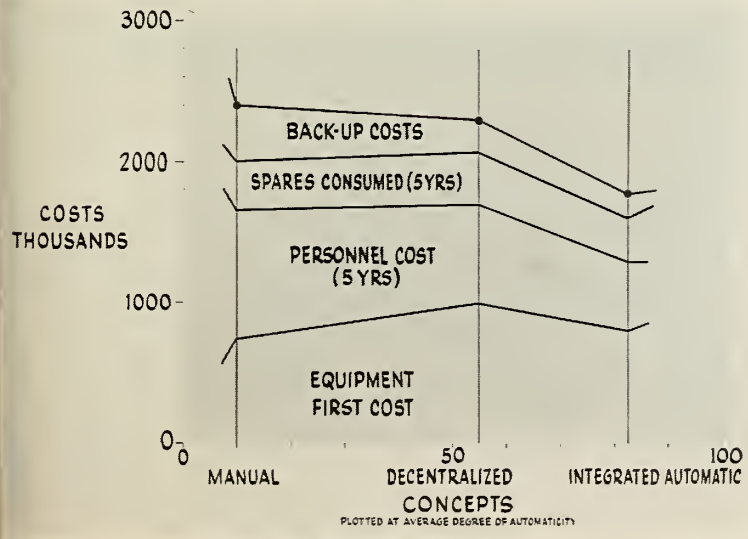
First, the researchers made the assumption that, although doubtful, it is conceivable that three such vehicles might be serviced in the same high-workload logistic area.

The universal checker next created was one provided with one versatile core (A) and three special-purpose sections (X, Y, and Z).

Each of the three automatic integrated checkout systems had one versatile core representing 40% of the hardware and cost.

Total cost of the universal checkout system capable of serving three weapons systems was $4.5 million. Cost of the three individual special-purpose units

(Continued on page 42)



Average Costs of Concepts

Blast-Resistant Communications Guar

Collins-developed system at SAC's Fairchild base takes over-pressure shock waves up to 25 psi; even antennas have heavy protection

A "TOUGHENED" microwave communication system—reportedly the first ever built—has been installed at the *Atlas* missile base at Fairchild AFB, Spokane, Wash.

Protection from over-pressure ground shock waves up to 25 psi and automatic fault-sensing and reroute switching are the most novel features of the system, developed by Collins Radio Co.

Equipment racks at each launch site are installed on specially designed shockmounts 20 feet underground in concrete and steel bunkers. Four-foot antennas used for most terminals are mounted in concrete pedestals and protected by high-strength plastic radomes.

The system can provide a total of 480 3-kc voice channels to serve the widely dispersed launch sites and the command post control center.

A total of 862 channel ends are currently being used for channels carrying the various command and control circuits. The system can be expanded to 600 voice channels. Fault-alarm and automatic switching circuits are provided exclusive of the voice multiplex.

Basic system design includes three loops. One provides primary and alternate routing for communication between the control center and a number of the *Atlas* launch sites, as well as additional drops at each site for intersite communication. Another loop handles the various additional launch sites in the same manner.



TOUGHENED COMMUNICATION SYSTEM connects Atlas launching sites with control center at SAC's Fairchild Air Force Base near Spokane, Washington. The system is designed to withstand all but near-direct nuclear blasts; all components with exception of antennas (at lower left) are housed in underground concrete bunkers.

tlas Base

An interconnect loop supplies primary and alternate circuits between the other loops and make available a small number of highly reliable circuits between all points of the system, originating either from Fairchild or other locations.

Communication functions within the primary loops are completely isolated by the use of dual r-f paths from the control center to adjacent repeaters. Baseband low- and high-pass filters are incorporated at these two repeaters through the interconnect loop to provide the required channels between the two basic loops.

Frequency-diversity operation is employed throughout the system, using combining techniques to yield a signal equal to or better than the best received path. R-f transmitters and receivers are stackable, making it possible to use a common waveguide and antenna system without resort to circulators.

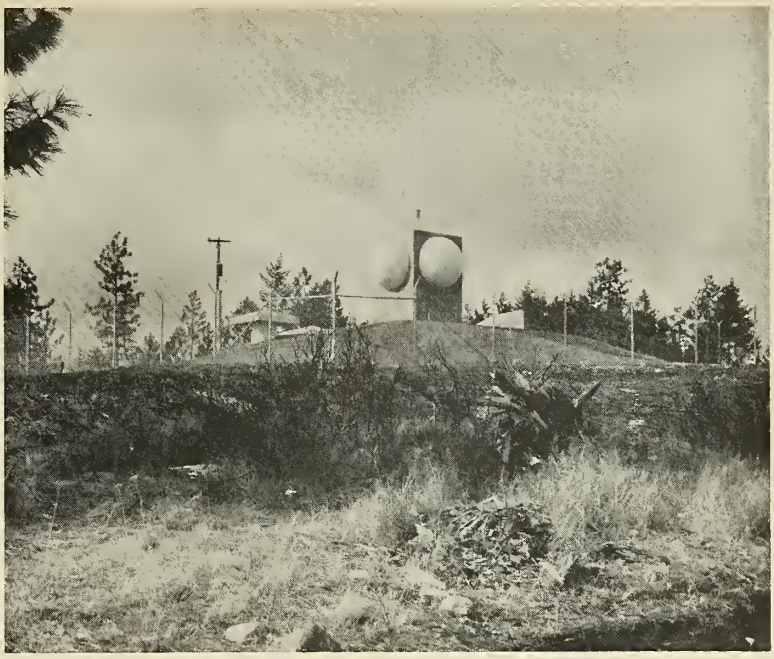
Since simultaneous fading on such widely spaced frequencies is extremely unlikely, the system provides the reliability called for by SAC requirements.

• **In emergencies**—A float-charged battery system is used for all installations. This provides 24, 48 and 130 volts for operation of d-c microwave, carrier, and signaling equipment without the use of rotary converters. The system can operate for as long as eight hours on battery power, in case of a failure of the primary power.

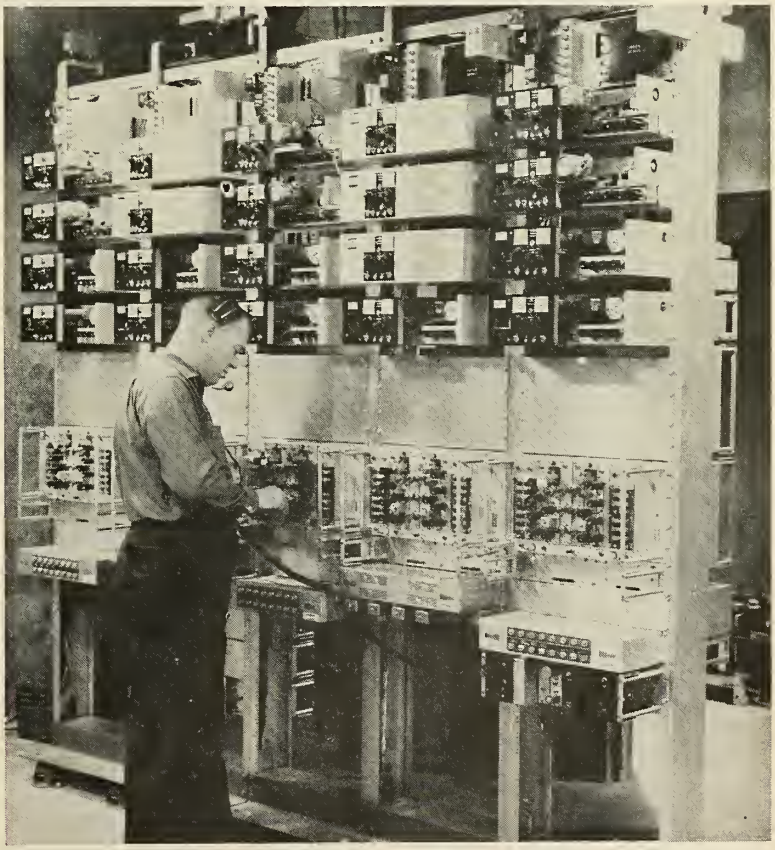
In event of any interruption to the normal circuit routing, the energized sensing circuits perform a dual function: activating baseband switching to reroute the channels, and activating visual and audible fault alarms at the control center.

The switching circuitry reroutes the inoperative channels within 50 milliseconds, allowing continued channel operation in a reverse direction, bypassing the affected terminal.

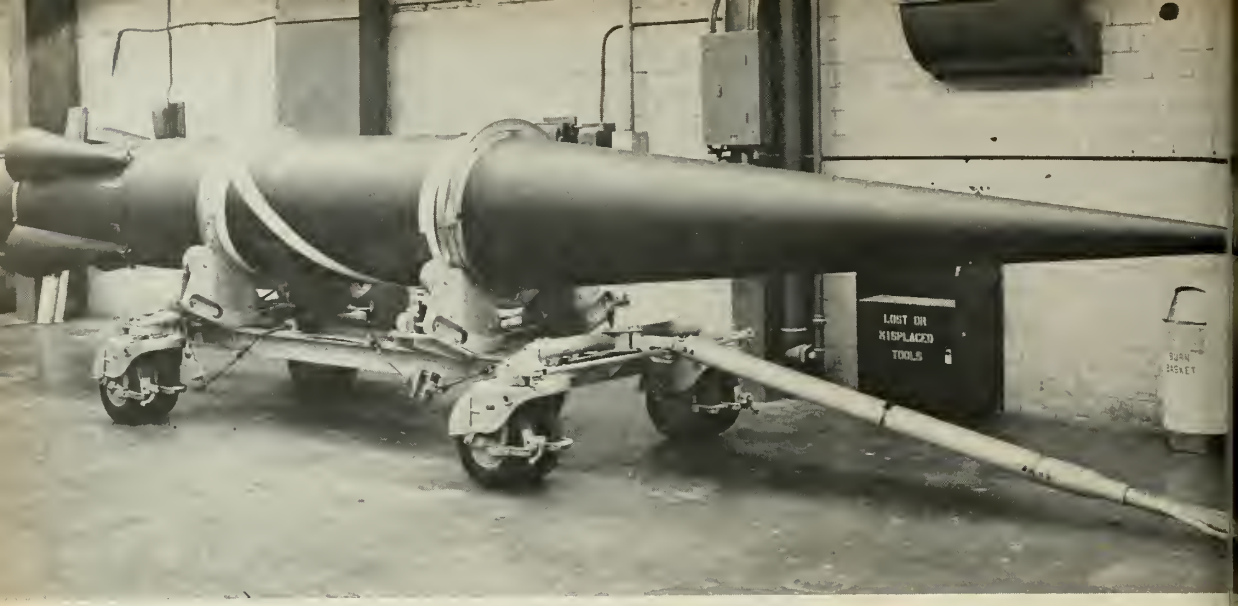
The fault alarm system detects six individual functions from each of the terminals and reports them to the control center. These are diversity path alarm, carrier common equipment switchover, r-f and carrier fuse alarm, unauthorized building entry, battery charger failure, and alternate routing monitor. ⌗



RADOMES of high-strength plastic nearly inch-thick, on heavy concrete pedestals, protect 4-ft. microwave antennas, only above-ground components of system.



EQUIPMENT RACKS in underground bunkers, including this five-way junction repeater, are shock-mounted to withstand shock and vibration pattern created by over-pressures of up to 25 psi, and designed for unattended operation.



ALPHA-DRACO vehicle minus first stage or booster

R&D vehicles

Hypersonic Boost-Glide Tests Poir

AF-McDonnell program using Alpha-Draco vehicle seems to indicate great potential—NACA drawing recalled

by John W. Herrick

BALLISTIC MISSILE range has been increased without raising propulsion requirements in the $5.5-million Air Force/McDonnell Aircraft Corp. program on hypersonic boost-glide vehicles.

Successful flight tests and wind tunnel studies also indicate that ballistic missile payloads can be increased through the same technique.

The McDonnell program involved the Alpha-Draco Hypersonic Research Vehicle, known in the work's early phases simply as an aeroballistic Research Vehicle.

First Alpha-Draco vehicle to be test-flown was propelled to Mach 5.0 at 100,000-ft. by integral solid-propellant rocket motor after a first-stage boost from an *Honest John* launcher by another solid propellant unit.

The McDonnell-designed and -manufactured flight control system directed the vehicle into a flat glide path after propulsion stopped, and vehicle range was stretched out beyond that of a pure ballistic trajectory by a still-classified percentage figure.

The vehicle maintained level flight on body lift alone. Wings would not improve performance, McDonnell engineers said, because of added weight, increased drag and heating.

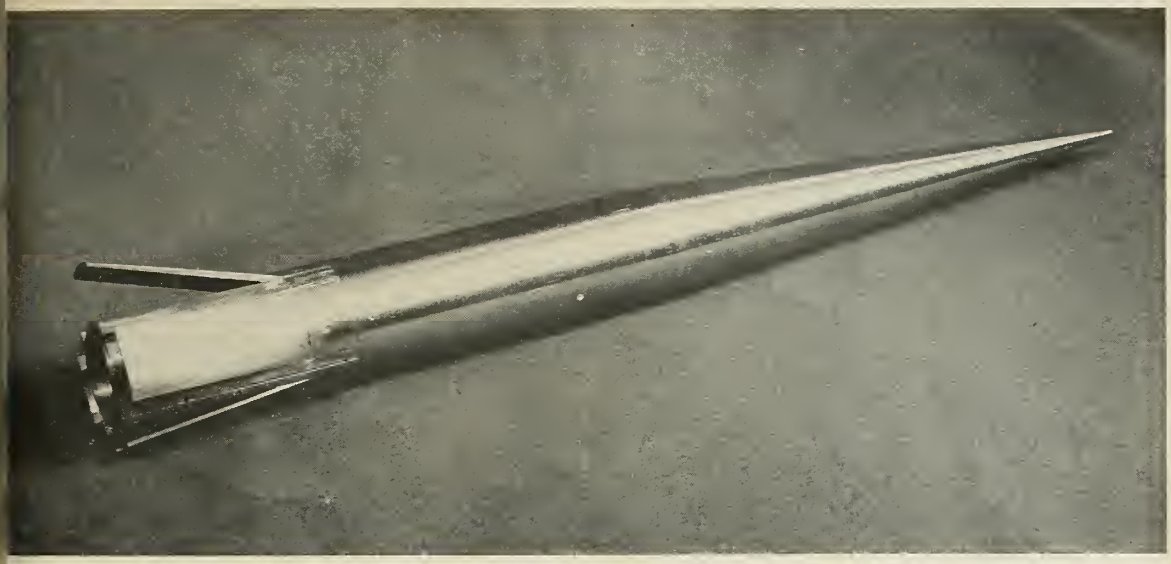
A ballistic dive was obtained at glide trajectory termination by trimming the stabilizers at zero angle of attack. During the dive to impact point, the stabilizers continued to correct the trajectory to compensate for wind shear and other perturbations.

The Alpha-Draco vehicle stayed within maximum permissible temperature limits, McDonnell's Missile Engineering Division says. The simple high-fineness-ratio symmetrical shape presented the advantage of minimum surface area for maximum volume. Reradiation and internal insulation protected internal components from heat transferred through the skin. Heat produced by power system components was removed by an internal cooling system.

One distinctive feature of the Alpha-Draco is the method employed to limit the effects of severe aerodynamic heating. A slow roll while in gliding flight eliminates localized heating and thermal warping by distributing the absorbed heat evenly over the skin and structure. The four aft bulk control surfaces control the roll rate as well as yaw angle and angle of attack. The cone-tipped cylindrical body is kept at the angle which gives the maximum lift/drag ratio.

The Alpha-Draco vehicle, also known as 122B, would appear to have definite research applications. Some possible uses outlined by McDonnell include:

- **Propagation research**—This effort would consist of studying characteristics of electromagnetic transmission through an ionized layer at Mach 8 or March 12. The 122B would be equipped with suitable transmitters and/or receivers to cover the band of frequencies and power levels. Signal deterioration would be measured by monitoring phase shift of the transmission.
- **Radar reflectivity characteristics**—An effort to determine the amount of radar reflectivity enhancement due to an ionized layer around a hypersonic body and following the body in flight.
- **Infrared radiation spectrum radar studies**—Primarily a passive effort in which ground tracking stations would track and define radiation spectrum of the missile.
- **Antennas** — Such materials as quartz-loaded teflon and pyroceram would be made into a variety of antenna configurations and examined at high speed for durability, electrical and thermal characteristics.
- **Range calibration**—The vehicle would replace present methods of At-



WIND-TUNNEL MODEL was tested at Mach 8.0.

ɔ Longer Range, Bigger Payload

ıantic Missile Range calibration in which ı subsonic aircraft is flown down range ıt relatively low altitudes. Use of Alpha-Draco would permit extension of calibration under higher speed and altitude regimes. Measurements of field strength from range radar and command transmitters would also be possible.

The vehicle could also be used for studies of structural temperatures by mounting small bodies on the 122B and instrumenting the bodies for loads, flutter and temperature. Ablation and transpiration studies could also be made.

Still other possibilities include use of the vehicle for surveillance studies, horizontal upper air measurements (wind shear, meteoric impact and atmospheric composition) and as a flying wind tunnel with scale models mounted on the vehicle's front end with measurements for lift and drag taken under a variety of attack and yaw angles.

Much of the thinking behind McDonnell's project is based on a concept proposed by Dr. Alfred Eggers, Jr., H. J. Allen and Stanford Neice in NACA (now NASA) report 4046, "A Comparative Analysis of the Performance of Long-Range Hypervelocity Vehicles." There is little visible difference between the Alpha-Draco and the original NACA drawing.

As pointed out by Eggers et. al., "The glide vehicle with L/D ratios of approximately four is far superior to the ballistic vehicle in ability to convert velocity to range . . . on basis of equal ratios of mass at takeoff to mass at end of propelled flight, the hypervelocity vehicle compares favorably with the supersonic airplane for ranges of one-half the circumference of the earth."

The NACA report offers a few more observations on potentials of the hypersonic glide concept.

The authors claim that the gliding bodies will be difficult to defend against, as well as being more efficient than ballistic vehicles. The report also claims that the glide vehicle is superior to the skip vehicle which experiences extremely large loads and severe aerodynamic heating.

McDonnell sources, however, decline to describe any specific applications of Alpha-Draco to obvious improvements in ballistic weapons, using the increased range capability to carry nuclear devices to targets now inaccessible or to confuse enemy countermeasures (anti-nosecone) system by not re-entering on a Keplerian trajectory. ⁂



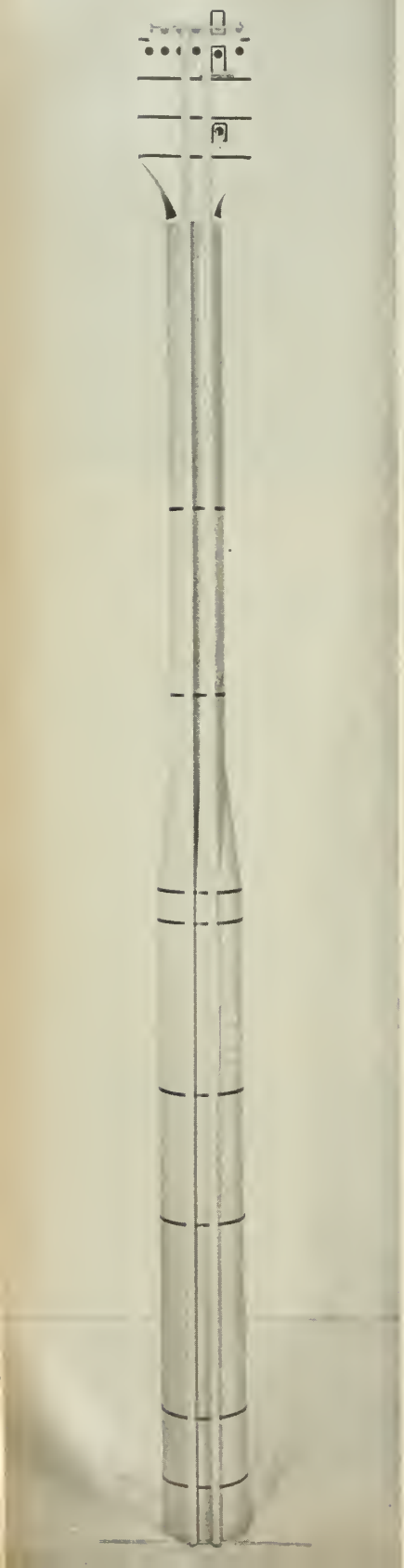
ALPHA-DRACO MODEL shown on toy Army launcher. First vehicle flown was given first-stage boost from Honest John.

Air Force Consolidates Its Hanscom Buying Operation

THE AIR FORCE has consolidated its contract and procurement operations at Hanscom Field, Mass., into a single office.

Previously, contractors dealt with the Research and Development Procurement and Systems Procurement Offices.

Consolidation is expected to result in better control of the buying activity by the Air Force, and to make it easier for contractors and representatives to reach their contact. Because of the simpler procedures involved, the Air Force feels the new setup will have special appeal to small businesses interested in AF contracts. ⁂



Weird 'Flip' Vesse

Research ship, longer than football field, will go to sea in horizontal position, switch to vertical to provide highly stable platform for submarine equipment

by Bill Wilks

La Jolla, Calif.—A research vessel with a 30-story-deep tubular hull is under development by the Office of Naval Research and the Marine Physical Laboratory of Scripps Institution of Oceanography.

Designed primarily in hopes of making a breakthrough in underwater submarine detection, the unique craft, 355 ft. from top to bottom, is dubbed "Flip"—short for Floating Instrument Platform. It will be towed to sea in a horizontal position and then literally flip to the vertical by ballasting its aft section with sea water, leaving only its four-story—55 ft.—bow above water.

A construction contract for the vessel, to be funded by the Navy, will be awarded soon following formal approval by regents of the University of California, which operates MPL for the Navy. The cost will run from $450,000 to $475,000.

In operation, Flip will carry four oceanographers and be allowed to drift with ocean currents and winds, controlling its draft by varying tank ballast. While floating on station it will be able to rotate about its vertical axis by means of two marine engines. It will have no other propulsion. A mother ship will attend Flip, although the crew could carry supplies to operate for up to two weeks. There are no plans to anchor it at sea.

Jeff Frautschy, assistant director of Scripps Institution, said Flip was expected to provide "a very stable platform that can carry experimental equipment below the thermocline, the water layer about 150 ft. down where a marked temperature drop begins."

Major reason for wanting to get below this level is "so we can experiment with some submarine equipment without having to use a sub," Frautschy said. The thermocline can shield a submarine from sonar detection.

"We need a very stable platform for a variety of reasons," Frautschy added. "For one thing, it will minimize hydrophone noise since motion relative to the water will be quite small."

Flips' first story, normally riding about 20 ft. above the water, will house two diesel engines and generators producing 120 kilowatts; the second story will provide living quarters; the third will house an electronics laboratory; and the top story will be a "wet lab" containing winches and other equipment. Each deck will have about 312 sq. ft. of floor area.

The crew will be able to descend dry through the tube to 150 ft. below water level, where observation ports may be installed.

Experimental gear and instruments will be lowered through two 2-ft. diameter pipes running top to bottom outside Flip's steel hull. Research work will include taking drill samplings from the ocean floor. An outside rail-mounted platform may be installed next to the pipes.

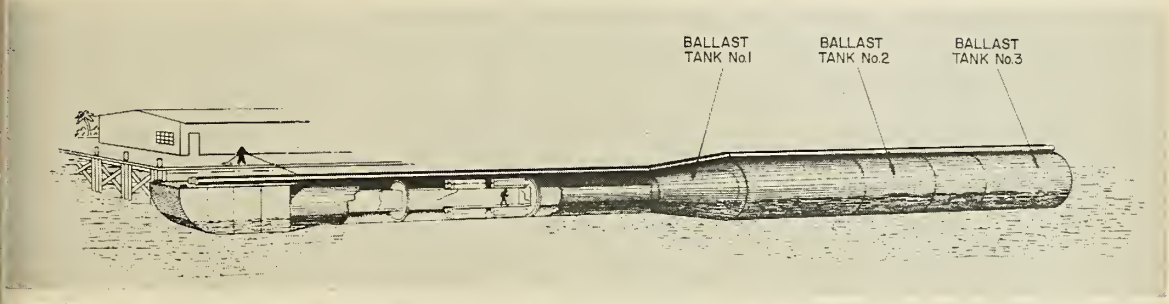
Immediately below the bow, Flip narrows to a tubular section 12½ ft. in diameter and 165 ft. long. The lower portion, including a "hard" ballast tank reinforced to withstand full pressure differential at that depth, and two non-pressurized tanks, is 20 ft. in diameter and 135 ft. long.

The vessel's simple ballasting controls are accessible in either position, while other controls are designed for vertical operation. The two powerplants are trunion-mounted for operation in either position.

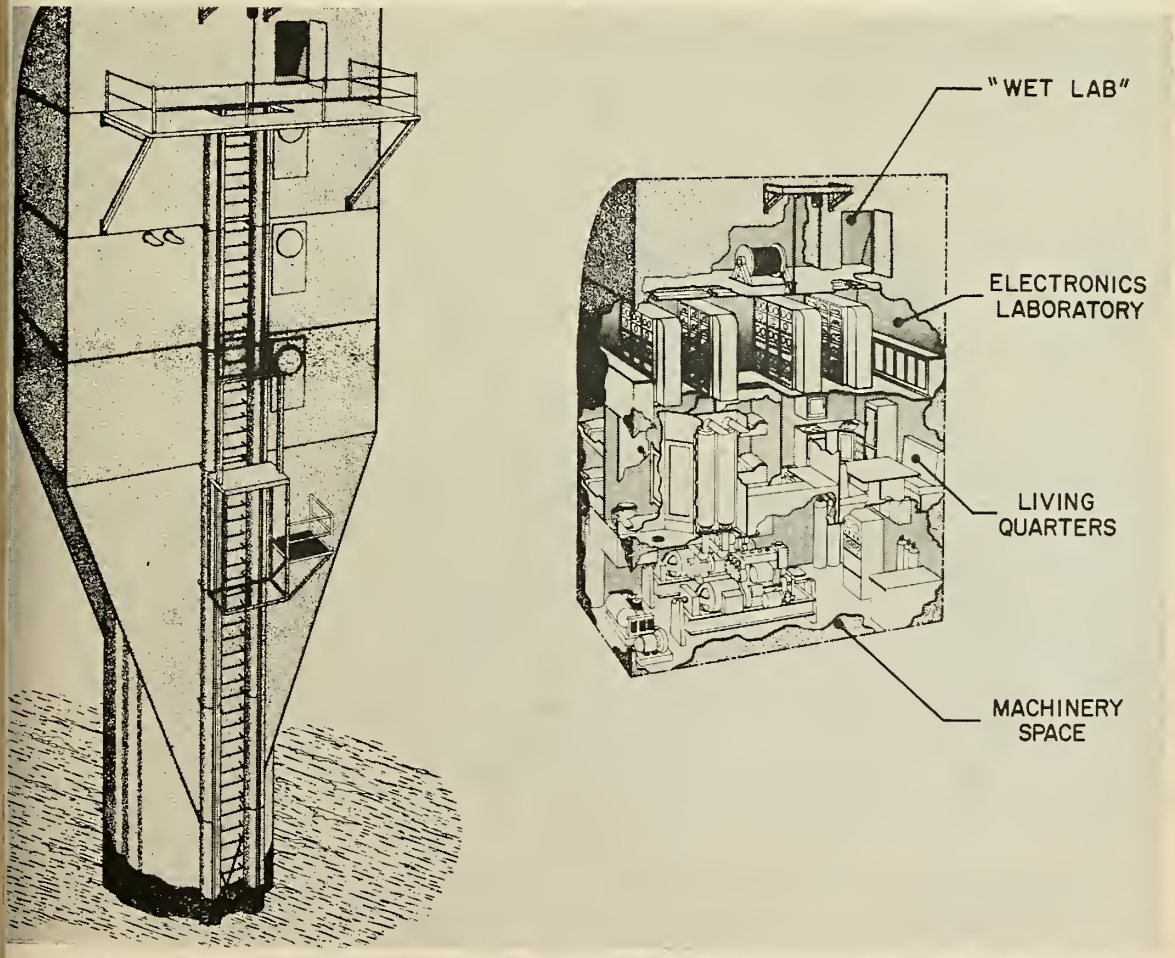
Because of its inherent stability, Flip should be able to "ride out a good-sized storm," Frautschy said. ⌗

CALLED the "ultimate vessel in oceanographic research," Flip—Floating Instrument Platform—will seek a Navy breakthrough in underwater detection of submarines.

Designed to Yield Breakthroughs



NEW 355-FT. FLOATING LAB will be towed to sea in a horizontal position, then flipped to vertical position, by ballasting tanks with sea water, so that all but upper 55 ft. of the vessel will be submerged.



UNIQUE RESEARCH SHIP, rearing from the sea like a giant periscope head, will drift with currents while its crew of four oceanographers carries out experiments. Crew will carry supplies for as long as two weeks.

Communication Satellites...

(Continued from page 11)

It was unofficially reported last week that the Space Council would meet shortly to discuss the staff reports on the study. There has been no definite statement as to when the study will be completed, but estimates run from one to several weeks.

• **Compromise at hand**—The study has apparently set back an FCC decision on ownership of the system. Although this was denied by FCC officials, a commission meeting on the problem scheduled for last week was not held.

As the study opened, commission officials declared that they and the Justice Department are not far apart on a compromise to settle the anti-trust question. Commissioner T. A. M. Craven said that a provision requiring any commercial enterprise operating the system to "call for competitive bidding on all procurement" might go a long way to settle the thorny issue.

It is quite possible, however, that the Council will recommend that other firms besides international communications carriers be allowed to join in the ownership of the commercially operated systems.

• **RCA stresses R&D**—One industry view was revealed by David Sarnoff, board chairman of Radio Corporation of America, who told a National Press Club audience that "the much-debated question of satellite ownership is, in my opinion, far less important at this time than the adoption of the right system at the earliest possible moment.

"To expedite the achievements possible in this area, we at RCA feel the time is ripe for the formation of a joint government-industry group to pursue an aggressive total effort in research and development.

"Through this collaborative effort, we can agree on the best satellite communications system. We can get it in operational orbit in the shortest time, and we can share with the world a remarkable technique for nation-to-nation seeing and talking," Sarnoff declared.

Two of the principal firms involved in presenting plans for the commercial satellite system have been the American Telephone and Telegraph Co. and General Electric.

• **A.T.&T.'s plan**—A.T.&T. initially plans to place 30 satellites in about 6000-mile orbits. It is thought that even if these orbits are random and uncontrolled, at least one will be visible both in the U.S. and Western Europe except for a period of less than two minutes a day. In a different part of the orbit, the 30 satellites can also provide service between the U.S. mainland and Hawaii.

The A.T.&T. plan also calls for satellites with repeaters to handle four broadband two-way radio channels. Each channel could carry 600 telephone signals or one broadcast-quality television signal. The firm estimates that by 1980 it will need 12 broadband two-way channels between the U.S. and Western Europe, including Britain.

Thus, by that year, 50 orbiting satellites will be needed to insure the probability that four satellites would be visible to the U.S. and European countries.

A.T.&T. has been authorized to use frequencies in the 4000 megacycle range for an experimental system.

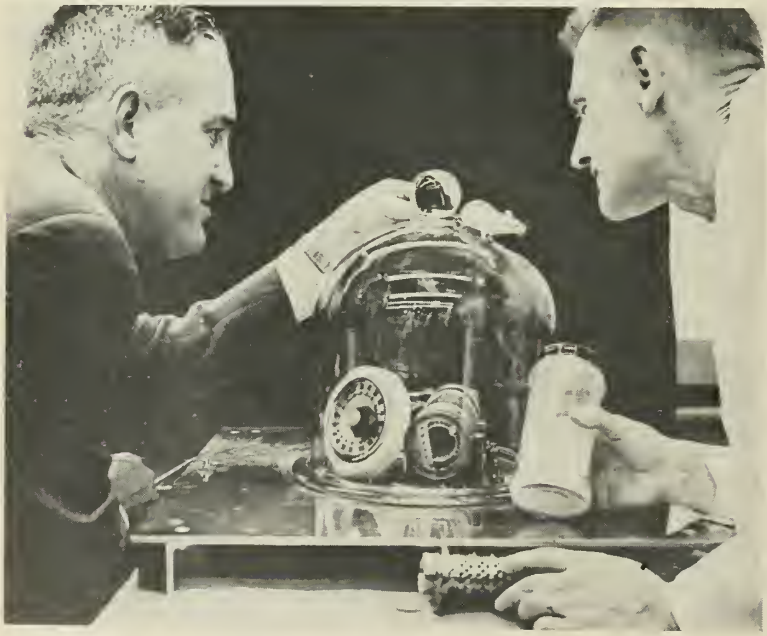
It claims that it has made considerable progress on the development of such a system and that at 4000 megacycles there is a loss of 185 db between an isotropic antenna on the ground and another one 6000 miles in space.

Through the use of a 60-by-60-ft. horn antenna, the firm says, it can get a gain of 57 db.

To permit launching with contemporary rockets it is thought that a satellite should weigh about 100 lbs. With a 27-in. satellite, 3528 solar cells will be distributed over 55% of the satellite's surface. These will operate a two-watt traveling wave tube and associated circuitry as power amplifiers.

• **G.E.'s challenge**—GE, through Communications Satellites Inc., is challenging almost every aspect of the A.T.&T. plan. The GE plan would involve 10 satellites in equatorial orbit—much like the *Advent* system which it is helping to build for the Army.

It claims that the equatorial approach is required to realize the full potential of international message traffic, since it would cover most of the globe's populated regions. It also contends that an equatorial system would require only 10 ground stations, while a polar system would require many more to provide multi-directional service. ¤



Wee Un-timorous Beastie

MOUSE IS STILL quite frisky after an 80-hour stint in a closed cell with potassium-superoxide regenerating oxygen supply. Lockheed Missiles and Space Company test showed that an amount of the oxygen-regenerating chemical weighing as much as the mouse itself was used up every 20 hours. Excess oxygen produced by the highly active chemical was bled off by a specially designed regulator.

ARS Members to Play Host to IAC Delegates

FOREIGN DELEGATES attending the International Astronautical Congress in Washington this fall will have a good chance to communicate with American scientists and engineers.

Members of the Washington Capital Section of the ARS, hosts to the IAC, are inviting visiting delegates to be their houseguests while in Washington.

The XIIth IAC will convene Oct. 2 through 7. ¤

AF Probe Finds Heavy 'Dust' Band

AN AIR FORCE experiment has confirmed that a dense band of micrometeorites envelopes the earth at high altitudes.

Spokesmen for the Cambridge Research Laboratories, which directed the tests, said the density of the micrometeorites was totally unexpected, although the existence of the layer has been suspected for some time.

The band was discovered by an ingenious device carried in the nose cone of an *Aerobee-Hi* rocket launched from White Sands, N.M., June 6. Further tests were made June 23 by a *Nike-Cajun* research rocket launched from the Air Proving Ground Center at Eglin AFB, Fla., results of which have not been disclosed.

The *Aerobee-Hi* rocket carried a particle-trapping device which operated much like a Venus flytrap plant. It opened at an altitude of 47 miles and closed at 65 miles. Time of exposure was about four minutes.

The nose cone carried two types of micrometeorite detectors. On the "leaves" of the device were triple-layer sheets of mylar and plexiglass. Micrometeorites traveling faster than 47 mps passed through the two top layers (¼-mil and 1-mil-thick Mylar) and created craters in the harder, ⅛-in.-thick plexiglass bottom layer.

A few craters also were found in the second group of detectors, which were thicker films of Millipore, Formvar and Lucite plastics.

Only a few micrometeorites actually were collected, since for the most part they vaporized on contact. However, residual amounts of the material were found lining the walls of the craters.

Most of the analysis of the films will be done by electron microscopy techniques, since many of the individual particles are smaller than the wave length of light.

AFCRL said that a large number of samples would be furnished to interested, qualified scientists for analysis.

Dr. Robert K. Soberman of CRL has theorized that the layer is formed by electrostatic trapping.

Thomas G. Ryan of AFCRL supervised the recent tests. Assistance was provided by Aerojet-General, Fullam Laboratories and Dudley Observatory in Albany, N.Y. for the *Aerobee-Hi* test. Test package for the *Nike-Cajun* rocket was prepared by Temple University. Philadelphia. ⁂



Proposed Three-man Station

GENERAL DYNAMICS/ASTRONAUTICS artist's conception of the division's proposed three-man Manned Astronautical Research Station (MARS) in operation in an orbit 200 miles above earth. The station in orbit would be linked to a spent Centaur rocket vehicle. The two bodies would rotate about each other, the resulting centrifugal force providing the necessary artificial gravity.

Taped System Slashes Inspection Time

PRECISION missile parts can be automatically inspected with a new, highly accurate tape-controlled measurement system developed by Sheffield Corp., a Bendix subsidiary.

The 16-ton system can complete almost 1000 precise measurements in two hours—a job requiring up to 125 hours by any other method. In addition, Sheffield says, the system is much more accurate than other techniques. The gaging machine is so sensitive it can automatically detect a deviation as small as 0.00001 in. from specified dimensions.

The part to be measured, for example a missile nose cone, is mounted on a rotary base plate. Electronic "fingers", or gages, "feel" the inner and outer surfaces of the part. Signals from these sensors are automatically converted to extremely accurate measurements of contours and thickness.

The part's nominal dimensions, encoded in serial form on punched tape, are used as command signals for positioning the workpiece slide and the vertical slides carrying the gage cartridges. With the gages positioned for a given horizontal plane, the part is rotated about its vertical axis, either in controlled steps or continuously.

Deviations from the nominal dimensions are printed out in tabular form as well as visually indicated for various points on the plans. The number of planes as well as the number of points of inspection depend upon the part specifications. For a part such as the transparent hemisphere shown in the photos, a point of inspection might be specified at every two degrees latitude and every 60 degrees longitude for outside contour, inside contour, and wall thickness. Such a program would require a total of 795 gage readings, including 265 mathematical computations for wall thickness. Total time for the inspection and data printout would be approximately two hours.

The machine is programed from the part's design specifications. The gage programer prepares a process sheet listing the X and Y positions of all the gage points on the parts to be inspected. This data is fed into a Flexowriter that produces a standard 8-channel code-punched tape.

The Bendix DynaPoint numerical control unit reads and executes each command as it appears on the tape. The command may be to move a slide a specific distance, rotate the table, or to perform auxiliary functions.

With sensors in gaging positions, the tape also initiates the gage readout cycle. Deviations from nominal size detected by the gages are fed into the analog-to-digital convertor, and the data is printed out in tabular form. ⁂

Souped-up Thor

(Continued from page 13)

has not been changed to any great extent, about 1180 lbs. has been trimmed from the booster.

Current *Thor* production follows a standard design in the upper-stage transition section, which is then fitted according to the vehicle's intended payload. Three regular transition sections are now in production on a separate line at Douglas: *Discoverer (Agena B), Transit (Ablestar)* and *Delta,* which has two upper stages.

Delta uses the operational-missile transition section with necessary modifications to accept the Aerojet-General second stage. The Allegany Ballistics Laboratory third stage is then added. Both the *Transit* and *Discoverer* stages require special transition sections, and the former is further modified by the inclusion of exhaust ports and guide rails.

The exhaust ports consist of two door openings and two rows of holes covered by a two-foot-wide steel band. The *Transit* second-stage engine is ignited after mainstage burnout but before separation, and while the *Thor* vernier engines are still burning.

The port-covering band is then blown off by explosive bolts, almost simultaneously with stage separation action.

Approximately this same technique is used to separate upper stages of the *Delta* booster. Exhaust gases from the upper-stage engine are vented through the 24 six-inch ports located in a ring around the base of the transition section. A blast band, also used to cover these ports, is detached with explosive bolts at second-stage ignition.

Panel fairings give additional venting area. They are peeled back by spring-loaded actuators at ignition.

Discoverer payloads using Lockheed's *Agena B* are separated by retro rockets, and the *Agena B* engine—a Bell Hustler—is ignited only after a variable coast period has passed. The vehicle has both zero-g and space restart capabilities.

A flight controller has thus far been used in all *Discoverer* firings to guide the vehicle along a programed trajectory until booster burnout. The Air Force now plans to greatly improve final booster-positioning accuracy by limiting programed flight to about the first 90 seconds. Ground control will then take over, using Bell Telephone Labs' radio guidance system, and precisely position the booster until burnout.

The solid-state BTL guidance system reportedly "threads the eye of the needle" to greatly reduce corrections ordinarily made by the upper stage. Booster velocity, angle and attitude are monitored closely before burnout, so that the *Agena B* is at optimum position for the intended orbit.

• **Thor performance record**—Douglas considers itself akin to the father whose son has hit the winning home run.

From the date of the first *Thor* launch in January, 1957, the booster has had 117 launchings. Of these, it has performed its mission successfully in 43 of 51 space-mission launches, including 36 scientific space projects and seven re-entry test vehicle firings for nose cone R&D. Additionally, there have been 49 research and development firings of the vehicle itself, and 17 training shots by USAF and RAF.

Future assignments for *Thor* will include further *Discoverer, Delta* and *Transit* satellites, as well as *Nimbus, POGO* and other payloads. ⌗

Automatic Checkout

(Continued from page 31)

was $5.8 million.

But the fallacy in these figures, Martin believes, is that three low-workload logistic areas are much more likely to be used than is a single high-workload area. Thus, if a universal checker were to be employed, three such systems would be needed—at a cost of $13.5 million, well over twice the cost of three special-purpose systems.

The study report indicated that the individual unit would be significantly more effective from all points of view. Also, the common versatile core employed by each could be drawn from an appropriate stockpile, and hence effect considerable dollar savings.

• **Average costs**—In an across-the-board survey of costs, Campbell's group plotted average costs of performing checkout tasks by each concept for all of the various weapon systems.

Costs were broken down this way:

—Equipment—initial expense based on one system of a production quantity.

—Personnel cost over a five-year period. This included training, salaries, etc., for a full complement of checkout personnel.

—Spare parts, including those consumed and stocked during a five-year period.

—Back-up costs. These covered all logistic and overhead factors, including weapon in-service rates. These costs, said Campbell, were distributed among each of the checkout concepts at the rate of $1000/minute of checkout time.

The integrated automatic system approach proved to be somewhat cheaper than the decentralized semiautomatic concepts, and well under the manual concept. Personnel requirements appear to make the greatest difference in cost between integrated vs. decentralized concepts, Martin said, but it believes both will be required.

• **Future trends**—Checkout of future space vehicles will be based on an expected reasonable workload consisting of a number of planned subsystem changes. The vehicles themselves, said Martin, will fall into both decentralized and integrated checkout categories.

As these vehicles follow a normal evolution, checkout requirements will gradually include a higher workload, with a progressively lower number of planned modifications.

The degree of weapon integration will tend to increase, Martin believes, and checkout equipment will tend to change accordingly. This means that the initial design of checkout systems should be reasonably automatic and multipurpose.

Checkout for later phases of these programs will require equipment more highly automatized and more nearly special-purpose. ⌗

Defense Dollars

(Continued from page 10)

and would require almost as much energy to change orbits as it needs to get into orbit. This deficiency may be overcome with on-board propulsion in a glider weighing 20,000 lbs. or more, compared with the present configuration's 10,000 lbs.

The committee ticked off several other areas of disagreement with DOD:

• **Polaris**—It said there should be provision for long leadtime items beyond the 29th boat, where the Administration has decided, for the present, to stop. McNamara said he was "delighted" the committee would entertain a request for reprograming of funds, but indicated no change in position.

• **Railroad Minuteman**—It has "reservations," the committee said, over the decision to slow up development of a mobile *Minuteman* system. McNamara, who has relegated this project to the back-burner of R&D, replied that *Polaris* was an "effective substitute" and it would be a "serious error" to risk the fixed-base program while accelerating the mobile.

• **Aerospace Corp.**—In chopping $5 million from the $35.2 million requested for the Air Force's non-profit management firm, the committee charged Aerospace Corp. salaries were "excessive," its overhead costs were too high and "it plans to employ too large a staff." But McNamara said he saw no difference between Aerospace Corp.'s president receiving $75,000 a year (it handles $35 million in contracts) and the president of a large defense contracting company who receives $125,000 "doing the same work." ⌗

Vega Might be Antiaircraft Weapon

by Bernard Poirier

NORD AVIATION'S *Vega* research vehicle may have potential as a Mach 4 or 5 antiaircraft missile.

First released details of Sahara desert tests have shown that the 32.5-ft. *Vega* maintains marked capabilities at angles of incidence. A Nord spokesman says the vehicle's adaptability to widely varying flight conditions, together with its load factor characteristics in pitch and other capabilities, makes it highly promising for many uses. It could be a highly efficient vehicle for solving aeronautical control problems.

Its solid booster is 12 ft. 5 in. long, with a 22 in. OD and 11 ft. 8 in. wing span. Impulse varies between 120 and 130 tons/sec., depending on grain length. Short grain length weight is 2340 lbs., with burning time just shy of 5 secs.

The sustainer is a canard-configuration ramjet 19 ft. 3 in. long, with a 25 in. OD and 6 ft. 3 in. wing span. Fueled weight of the experimental version is 1430 lbs.; it carries a 31.7-gallon kerosene supply.

Fuel capacity can be increased to 66 U.S. gallons by utilizing some payload space. Another 3.2 gallons can be added by lengthening in 4-in. increments.

The ramjet has forward control surfaces with very sharply swept cruciform delta wings equipped with roll-stabilizing spoilers. Its design utilizes a double-skinned body with resilient struts to fit the rear of the diffuser to the master frame and its front to the central body, permitting differential expansion.

More than advertised—O.N.E.R.A., French counterpart of NASA, chose to use a photo of the missile on the cover of the brochure it prepared for the Paris Air Show. Before *Vega's* details were released, Maurice Roy, O.N.E.R.A. chief described the "cover missile" as "simply an experimental high-Mach ramjet vehicle with a solid booster."

It has since been learned elsewhere that the Nord *Vega* operates in level flight from "Mach 3 to Mach 5 between 65,000 and 115,000 feet" and uses a "Vesuve"-type propellant grain to reach the ramjet launching speed necessary "between Mach 2 and Mach 3." The ramjet has gone through its paces using kerosene fuels meeting French, British and U.S. specifications.

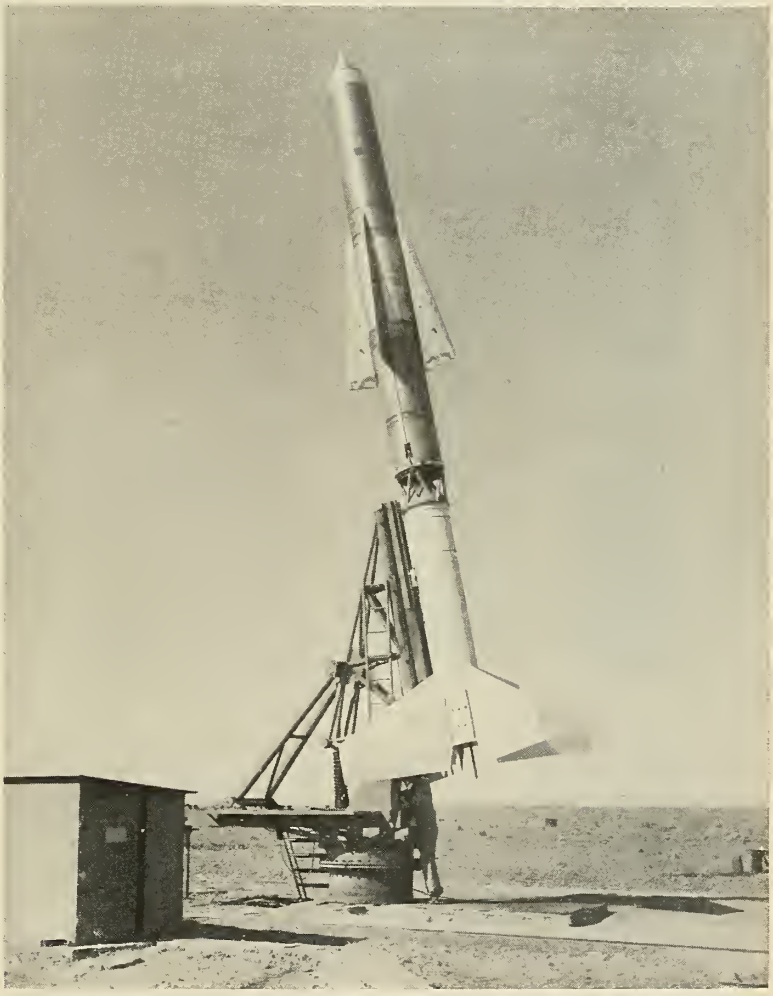
A prime supporting element on the research missile has been described as a highly-stiffened and double-skinned body supporting the wings or secondary attachment and designed to withstand heat gradients.

The refractory alloy combustion chamber terminates in a convergent-divergent nozzle; a frame section at this point links the sustainer to the booster.

A 5-cu.-ft. front payload area is located between the tip of the cone and the lip of the outer diffuser. Two rear compartments, totaling 2.5 cu. ft., are divided in two cone frustums which, in the experimental version, contain the drag chute and a 646-sq.-ft. main chute which slows the spent vehicle to a 30 ft./sec. rate of descent for recovery.

The booster, affectionately nicknamed "Fanny" by the launching crew, uses propellant grain 7.5 to 8.2 ft. long and has a Vascojet 90 steel casing and a steel exit nozzle incorporating a graphite throat section.

The addition of *Vega* to Nord's long line of developments is further advancing the firm's position as one of Europe's most capable missile manufacturers. ⌗

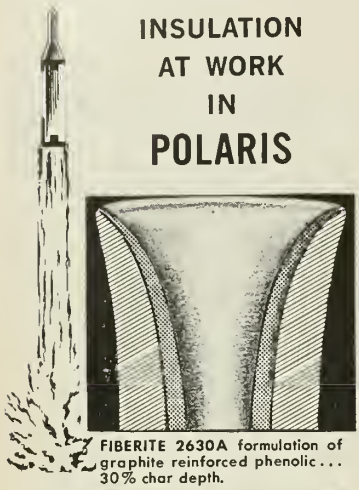


NORD AVIATION'S VEGA research missile being checked out at Colomb-Béchar range in Sahara. Note size of man below booster of 32.5-ft. bird. Missile attains Mach 4 speeds in level ramjet-sustained flight.

example...

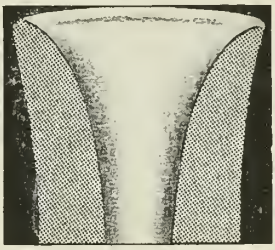
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soviet affairs

By Dr. ALBERT PARRY

Missiles doom aircraft carriers—

proclaims a recent issue of *Krasnaya Zvezda*, the daily organ of the Soviet armed forces, in a lengthy article entitled "Reappraisal of Values," and subtitled "Aircraft Carriers in the Plans of American Strategists." It points out that aircraft carriers (there are none in the Soviet Navy) are on the decline because "rocket-carrying submarines with atomic engines are beginning to play an increasingly large role in the Pentagon's military plans."

Captain V. Lan, author of the article, also states that "American admirals nevertheless believe that the aircraft carrier fleet will yet play a prominent role in the implementation of the Pentagon's aggressive plans." The Soviet writer dismisses this hope as unrealistic: "Although it is as yet incorrect to say that leadership in the American navy has already shifted from aircraft carriers to submarines, the trend is certainly that way." Rocket-carriers are replacing aircraft carriers. Lan concludes.

Knowledge of physics

is a "must" for Russia's new cosmonauts, according to Maj. Gen. George I. Pokrovsky, who doubles as a well-known professor of astrophysics and a high-bracket expert in practical rocketry. He writes in the May 26 *Krasnaya Zvezda*: "The future cosmonaut should, step by step, develop an ability to think scientifically. For this he must master the basic disciplines of physics and mathematics, perhaps even at the university level, but within strictly delimited lines, to avoid his overloading with details of secondary importance. At that, particularly useful is a thorough study of physics—the science, which is the basis and the unifier of all kinds of modern technology, and which permits one to use this technology reliably, under most complex and unexpected conditions, extracting from it a maximum of opportunities."

A jet pilot is the best possible cosmonaut

psychologically, says Yu. Fedotov, a candidate of the medical sciences, writing in the same issue of *Krasnaya Zvezda*. In a detailed discussion of psychological preparation of cosmonauts, Fedotov reports that "the majority of scientists are now in agreement that the first cosmonauts should be flyers with a record of having piloted modern jet planes," because "this in itself is good psychological training and the best means of discovering the psychological qualities needed by outer-space pilots."

He lists these qualities: ". . . an ardent heart, quick mind, steely and balanced nerves, unbending will, stability of spirit, vigor and cheer, lust for life, alertness . . . an ability to orient himself in the complexity of a flight, to react to its changes rapidly, and to make the right decision in a suddenly evolved situation."

Outer space is like a stormy ocean

in the simile suggested by Academician Sergei N. Vernov, a Soviet specialist on radiation belts (a year ago he won a Lenin Prize for his cosmic radiation researches). Quoted in the April issue of *Znaniye–Sila*, Dr. Vernov compares a flight in a rocket to a ship's crossing of an ocean's raging waves. He remarks: "Radiation belts are a kind of 'reefs' in the ocean, while magnetic disturbances caused by flares on the sun are like sea-storms. It will be necessary to chart a spaceship's course with great skill in order to avoid these dangers."

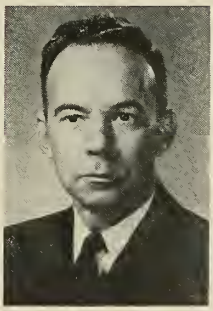
Microminiaturization in Czechoslovakia

was reported in *Krasnaya Zvezda* May 17. Czech scientists, it said, have succeeded in substituting for an electronic oscillator 850 cubic centimeters in size and 200 grams in weight a new instrument of 1.2 cubic centimeters weighing 2 grams. The new device uses 10 times less electric energy than the older, bigger oscillator.

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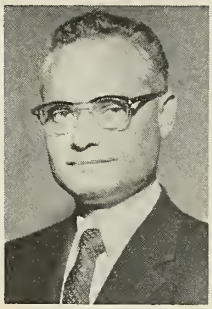
BROWN



DOHERTY



VAN DER WAL



BARANOW



LEESON

Cmdr. Paul H. Backus, USN (ret.): Former head of Ballistic Missile Group on Adm. Burke's staff in the Office of Chief of Naval Operations, joins Sanders Associates, Inc., Nashua, N.H., as corporate coordinator of special assignments.

William C. House: Corporate director of Nuclear Operations, Aerojet-General Corp., Azusa, Calif., named director of Nuclear Engine for Rocket Vehicle Application Operations. NERVA is part of Project *Rover,* a joint AEC-NASA program for the development of a nuclear rocket propulsion system. **Charles H. Trent,** manager, Nuclear Propulsion Division, appointed associate director of the program.

Patricia L. Brown: Information services supervisor, Semiconductor-components Div. of Texas Instruments, Dallas, elected president of the Society of Women Engineers.

Dr. Robert E. Payne: Named director of the Atlantic Missile Range Office of Aerospace Corp., succeeding **Morton Goldman,** who will return to headquarters in El Segundo, Calif., to assume a new program directorship.

Robert F. Garbarini: Promoted to chief engineer of Sperry Gyroscope Co.'s Air Armament Div., Great Neck, N.Y. Garbarini also serves as a technical consultant to the guidance and control panel of the Air Force Scientific Advisory Board.

Capt. John C. Doherty, USN: Named to command the Naval Missile Facility, Point Arguello, Pacific Missile Range, late in July, succeeding **Capt. William J. Scarpino,** who will attend the Industrial College of the Armed Forces, Washington, D.C. Doherty currently is on the staff of the commander-in-chief, Atlantic Fleet.

Arthur B. Billet: Senior staff engineer with Vickers Incorporated, Div. of Sperry Rand Corp., Detroit, elected president of the Institute of Enivronmental Sciences.

Roy Blum: Named general manager of Cryogenics, Inc., Stafford, Va. With the company since its founding, Blum will head up newly-expanded fiscal and administrative operations.

Edgar G. Grant: Former engineering manager, named director of new product planning for the Military Electronics Div., Daystrom Incorporated, Archbald, Pa.

Laurel van der Wal: Head of Bioastronautics, Space Technology Laboratories, Inc., Los Angeles, presented the 1961 Society of Women Engineers Achievement Award. Earlier she was named 1961 Woman Scientist of the Year by the Los Angeles Times and the Aerospace Medical Assn. Wives' Wing. A specialist in engineering problems of manned space flight, Miss van der Wal is best known for originating and implementing Project *MIS,* in which mice rode to space in the nose cones of *Thor-Able* rockets.

Dr. Sanford Baranow: Formerly with the Aircraft Nuclear Propulsion Dept., General Electric Co., Evendale, Ohio, joins the Materials Dept. of Tapco, a division of Thompson Ramo Wooldridge, Inc.

Dr. Bruce A. Reese: Former professor of mechanical engineering and associate director of the Jet Propulsion Center, Purdue University, named deputy chief of the Anti-Missile Missile and Space Defense Projects office of the Army Rocket and Guided Missile Agency.

James L. Anast: Former president of Lear Corp. and director of FAA's Bureau of Research and Development, appointed Chance Vought's Corp.'s manager of European Operations, with headquarters in Paris.

Allan B. Schaffer: Formerly with Space Technology Laboratories and Aerospace Corp., joins Clauser Technology Corp., Torrance, Calif., as a senior scientist in magnetohydrodynamics.

Edward C. Leeson: Named vice president and manager of Kidde Aero-Space Div. of Walter Kidde & Co., Inc., Belleville, N.J. Previously Leeson was vice president of marketing, Kollsman Instrument Corp.

Dr. E. C. Heubschman: Formerly with Convair Astronautics, joins Pan American's Guided Missiles Range Division as space instrumentation specialist in the Technical Laboratory. Other appointments to the Laboratory: **Howard J. Elmore,** instrumentation planning engineer with Technical Systems Planning; **E. W. Hannum,** veteran Pan Am engineer, transferred from the Overseas Div. in New York; **G. A. Wegmann,** formerly with Philco Corp., to work in Data Reduction Systems.

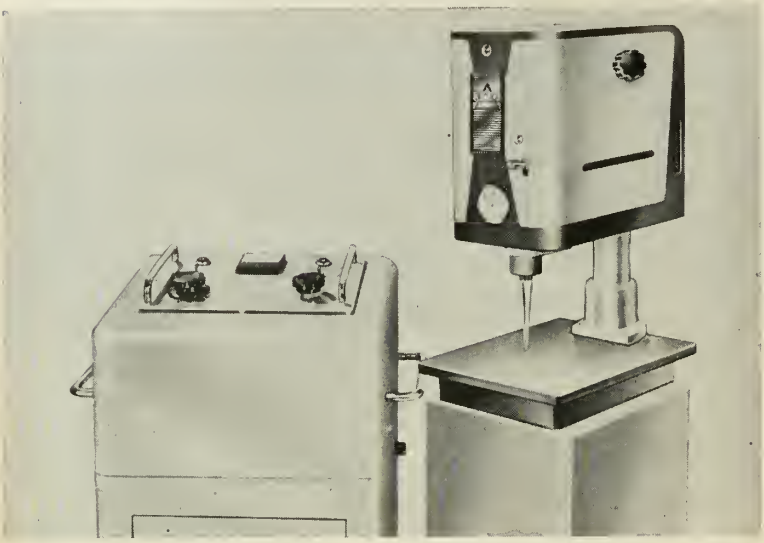
Paul J. Colleran: Former manager of General Electric semiconductor advanced engineering, joins International Rectifier Corp., El Segundo, Calif., as vice president for engineering.

Peter A. Button: Joins Electro-Optical Systems, Inc., Pasadena, Calif., as a senior scientist in Advanced Electronics and Information Systems Div. **Dr. Paul C. Fletcher** has been named principal scientist and manager of the Laser Dept. of the Quantum Physics Div. Prior to joining EOS, Button was a research physicist with Radiation, Inc.; Dr. Fletcher was with Hughes Research Laboratories.

Harold D. Kube: Elected to board of directors of Frederick Research Corp., Wheaton, Md. **Joseph F. O'Marah** joins the headquarters management staff as special assistant to the president in research and development operations. **A. H. Sullivan, Jr.,** named director of Advanced Systems Development.

Charles M. Mooney: Former director of government relations and world-wide integrated systems, elected vice president, U.S. Defense Group, International Telephone and Telegraph Corp., New York City. Mooney succeeds **Adm. Ellery W. Stone,** who will continue as vice president of the parent corporation, and assistant to the president—as well as chairman of the board—of American Cable and Radio Corp.

Louis Kraff, Jr.: Manager of the Space Instrumentation Div. of Technology Instrument Corp., elected to the board of directors of United Systems Corp., Washington, D.C. Formerly Kraff was chief of the Rocket and Instrumentation Branch of the Air Forces' Geophysical Research Directorate.



Ultrasonic Plastic Welder

An industrial tool utilizing ultrasonic energy for the sealing of plastic film and synthetic fabrics has been introduced by Ultra Sonic Seal, Inc. The unit permits the fusion of materials which have resisted or been ineffectively welded by standard processes, even though contaminated with oil and grease. Plastics which can now be instantly and permanently bonded include Mylar polyester, polyethylene, polypropylene, nylon and vinyl films, etc., and synthetic woven fabrics of nylon, and Orlon acrylic and Dacron polyester fibers.

Use of the sealer requires no special training for operating personnel. It does away with set up or down time between jobs; changes in adjustments are easily made. Featuring low-power consumption, it welds silently and quickly without expensive sealing dies. It can cut or seal, and makes butt lap, seam, spot or continuous welds.

Circle No. 225 on Subscriber Service Card

Automatic Cable Tester

A transistorized cable tester which examines each wire individually for leakage and short circuits between conductors resulting from defective insulators, improperly connected wires, cold solder joints or damaged wires is available from Automation Dynamics Corp. Deviations or resistance to 0.1 ohm for continuity and leakage up to 100 megohms are detected. The accepted or rejected wire is identified through clear digital readout. Sequencing on the instrument is either manual or automatic, adjustable to a maximum of one circuit per second.

Circle No. 226 on Subscriber Service Card



Pulse-to-Step Converter

A pulse-to-step converter, Slo-Syn Translator type ST-150, is available from Superior Electric Co. for use in programed positioning, remote positioning, indexing and indicating applications. The device is designed to convert low-level signal pulses or square waves into the correct switching sequence needed to drive a Slo-Syn Synchronous motor at 200 discrete steps per devolution. Speeds may be as high as 225 or 400 steps per second, depending on the motor used. Commands originate from information stored on magnetic or punched tape or from some other type of pulse generator.

Circle No. 227 on Subscriber Service Card

Conical Washer

A line of conical washer Keps® for mounting silicon rectifiers and other stud mounting devices is available from Shakeproof,® Division of Illinois Tool Works. The one-piece Keps combines both washer and nut to simplify handling and mounting. It has been designed to provide take-up spring pressure by utilizing a specially proportioned coned washer. This assures permanent contact between the rectifier and heat sink.

Circle No. 228 on Subscriber Service Card

Converter Amplifier

A single-channel, phase-sensitive, converter amplifier, Model CE-1, is available from Crescent Engineering and Research Co. The portable transistorized instrument is designed for use with potentiometers or a-c variable permeance and differential transformer transducers. It consists essentially of a power supply, oscillator, bridge balance control, gain control, amplifier and demodulator. The unit operates on 115 volt, 60 cycle a-c, provides a carrier

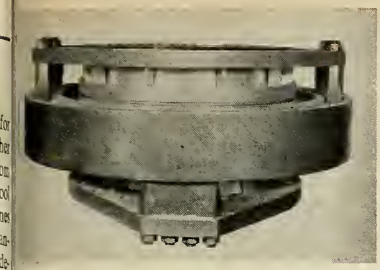


frequency of 1 kc to the transducer bridge and amplifies and demodulates bridge output providing a ±10 volts d-c output full-scale.

Circle No. 229 on Subscriber Service Card

Gimbal Expansion Joints

Gimbal-type expansion joints which absorb angular rotation in all planes are available from Zallea Brothers. Each gimbal expansion joint is controlled by a structural system consisting of two sets of hinges, oriented at 90°, coupled to a common gimbal ring. This structure restricts the expansion joint t



ngular rotation in any plane, absorbs pressure thrust and limits torsional loading on the bellows. It may be designed to carry piping weight, wind loads and other dead weights—thus eliminating guides, supports, anchors and restraints which might otherwise be required.

Circle No. 230 on Subscriber Service Card

Ferrite Core Memory

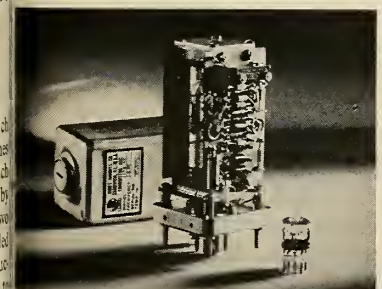
A high-speed, large-capacity memory unit is available from Ampex Computer Products Co. Designated the RQL, this ferrite core memory is available in a wide range of word capacities. Standard word capacity is 1024, 2048, 4096, 8192, 16,384, 32,768. All these word sizes can be obtained in 8-to-60-bit word lengths. Standard operating modes are random access with clear-write, read-generate, load and unload cycles. Also available are split-cycle, short-access and sequential-access. The unit is non-synchronous and all bits of a word are handled in parallel. Memory cycle is 6 microsec., access time 2.5 microsec. and buffer cycle 3 microsec.

Circle No. 231 on Subscriber Service Card

Ultra Stable Frequency

The JKTO-42, an ultra-stable frequency and time base, has been added to James Knights Co. series of compact, plug-in, transistorized oscillators. The JKTO-42 is a one-megacycle unit, employing a special JKG7 crystal designed for this frequency only. The oven is an a-c type proportional control unit that provides precise, automatic temperature control without cycling variations. It holds the temperature of crystal and associated circuitry within 0.005° at a fixed ambient temperature, and 0.01°C, or better, over an ambient temperature range of 0° to 50°C.

Circle No. 232 on Subscriber Service Card



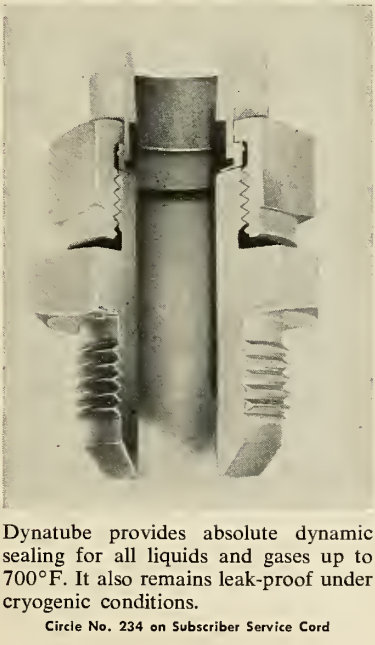
Solenoid Controlled Valve

Direct-operated, three-way, two-position solenoid valve MC-4565-1 is available from M. C. Manufacturing Co. This solenoid valve was developed primarily for use with MIL-H-5606A hydraulic oil at operating pressures up to 3000 psi throughout the temperature range of −65° to 275°F. The solenoid is of the continuous-duty type and conforms to applicable sections of MIL-S-4040C. It is completely sealed to prevent the possibility of damage by atmospheric humidity and foreign gases.

Circle No. 233 on Subscriber Service Card

Rigid Tube Coupling

A high-temperature, high-pressure rigid tube coupling with seal is available from Resistoflex Corp. The Dynatube maintains its seal under conditions of vibration, shock, pressure overloads, pulsing action or temperature variations.



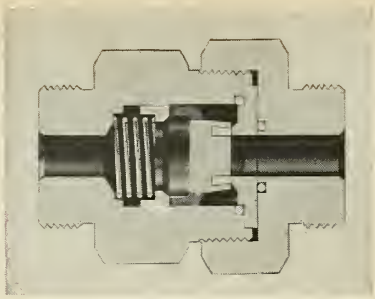
Dynatube provides absolute dynamic sealing for all liquids and gases up to 700°F. It also remains leak-proof under cryogenic conditions.

Circle No. 234 on Subscriber Service Card

Cross-Sectional Shapes

Metal shapes and forms of specified cross-section, especially adapted for development work, prototypes and pilot production are available from the Prontour Co. The Prontour process forms any strip-metal by a vibratory press action, using flat-plate "silhouette" dies which progressively fold the strip to the required cross-sectional form. Close tolerances are maintained and intricate cross-sectional shapes can be made. Shallow flanges, small curls and short legs may be readily formed with precision.

Circle No. 235 on Subscriber Service Card



O-Seal Check Valves

Surge and reverse flow are effectively eliminated in high-pressure liquid or gas systems with a line of silent check valves developed by the Combination Pump Valve Co. Combining a soft, resilient nylon seating principle with the engineered pressure of spring closure, these O-Seal check valves assure positive and leakproof shut-off at pressures to 6000 psi and temperatures from −20 to 275°F.

Circle No. 236 on Subscriber Service Card

Neutron Generator

Development of a low-cost portable generator of fast neutrons by Dresser Industries, Dallas, through its nuclear subsidiary, Well Surveys, Inc., brings to the field of commercially available radiation equipment a fast neutron source operating on 115-volt, alternating current. The unit can be turned on and off at will; when it is not being used it can be stored without safety precautions.

Circle No. 237 on Subscriber Service Card

Magnetic Memory Plastics

A thermo-setting plastic which can be spot magnetized to provide practically any desired pattern within a molded plastic part is available from Mesa Plastics. The compound, which has been tested beyond 400°F, includes non-conductive ferrite powder fillers capable of retaining either temporary or permanent magnetic charge. Polarity of the magnetic field set up may be oriented in any chosen direction.

Circle No. 238 on Subscriber Service Card

Packaged Power

A type of power package, consisting of a motor and high-ratio transmission completely sealed inside a stainless steel container, has been developed by United Shoe Machinery Corp. to overcome the effects of outer space on many of the actuating elements of missiles and space vehicles. These drives, which can be designed to meet the specific operating requirements for various space applications, are based on the Harmonic Drive principle of transmission.

Circle No. 239 on Subscriber Service Card



Microwave Generator

An "S" Band (3 kmc) stabilized signal generator providing full-octave bandwidth is available from Strand Labs, Inc. The instrument's design incorporates a unique patented Microwave Discriminator and high-gain d-c feedback amplifier providing automatic frequency control of the klystron oscillator to 0.01 parts per million, and frequency setability accuracy of 0.05%.

Circle No. 240 on Subscriber Service Card

Level Control Instruments

A line of level control instruments, including electric and pneumatic transmitters that also provide indication and can perform alarm and "on-off" control functions, is available from the Brooks Instrument Co., Inc. The instruments, utilizing a magnetic position converter, can be supplied in special materials for toxic, corrosive, and high-pressure (to 40,000 psi) services. They are available with buoyant and displacer floats for liquid or interface level or specific-gravity applications.

Circle No. 241 on Subscriber Service Card

Piezoid Ceramic

A piezoid ceramic material designated as Tyzamic-14 is available from Centralab. The material is available in an almost unlimited variety of shapes—discs, cylinders, tubes, plates and blocks can be supplied, as well as unsymmetrical shapes. The material has an extremely stable dielectric constant from 55° to 300°C. Transducer elements can be supplied with electrodes covering the entire surface of the element or limited to any designated area.

Circle No. 242 on Subscriber Service Card

Titanium Alloy Powder

One of the highest-strength materials that can be made by powder metallurgy processing is available from the Mechanical Research Division of Clevite Corp. Designated as CPT-64AV, this sintered titanium alloy has an excellent balance between tensile strength (119,000 psi). ductility (6% elongation), and hardness (Rockwell C 23). Strengths as high as 146,000 psi can be obtained by heat treatment.

Circle No. 243 on Subscriber Service Card

contracts

NASA

$660,000—**Vought Astronautics Div., Chance Vought Corp.,** Dallas, for production of six 105-in. diameter liquid oxygen tanks for *Saturn* space booster.

$379,000—**Radiation, Inc.,** Melbourne, Fla., from **Cornell Aeronautical Laboratory,** for microwave satellite transmitters.

$318,303—**Electro-Optical Systems, Inc.,** Pasadena, Calif., for development of a solar-energy thermionic conversion system.

$100,000—**Clauser Technology Corp.,** Torrance, Calif., for feasibility studies of a magnetic induction plasma engine for space vehicles.

DEPT. OF DEFENSE

$5,400,000—**Radio Corp. of America,** Moorestown, N.J., for engineering, fabrication, and checkout of the TRADEX radar being built as part of Project PRESS (Pacific Range Electromagnetic Signature Studies).

MISCELLANEOUS

$230,000—**United Technology Corp.,** Sunnyvale, Calif., from Edwards AFB, for research and development of an advanced high-performance solid propellant; from Office of Naval Research, for research work in the thermochemistry of the high-energy fluorine bond. (Two contracts.)

$228,000—**Electro Instruments, Inc.,** San Diego, from **Raytheon Co.,** for two advanced systems for high-speed in-plant testing of complex missile components and equipment.

NAVY

$16,400,000—**Sperry Rand Corp.,** New York City, as follows: **Sperry Gyroscope Co.,** $7,500,000 for modification and improvement of *Talos* missile guidance radars; $4,800,000 for continued production of new passive underwater detection system for submarines; $1,400,000 for radar engineering and technical services; **Sperry Piedmont Co.,** $2,700,000 for increased reliability and performance of original *Terrier* missile guidance radars.

$1,000,000—**Cryo-Therm, Inc.,** Fogelsville, Pa., from **Lockheed Missile & Space Co.,** for temperature stabilization systems for shipping *Polaris* missile guidance capsules.

$750,000—**Aircraft Armaments, Inc.,** Cockeysville, Md., from BuWeps, for design and manufacture of guidance monitors for *Terrier* fire control radars.

$340,000—**Zero Mfg. Co.,** Burbank, Calif., for containers for storage and shipment of electronic instruments and parts for *Polaris* missile system.

$150,000—**Daystrom, Inc., Pacific Div.,** Los Angeles, for control gyroscopes for Mark 44 torpedo.

$100,000—**Space Electronics Corp.,** Glendale, Calif., from Naval Ordnance Test Station, for dual-channel phase-lock receivers for tracking and telemetry in the *Transit* program.

Military Electronics Div. of Daystrom, Inc., Archbald, Pa., from BuWeps, for production of warhead adaption kits and repair parts for the *Terrier* missile. No amount disclosed.

ARMY

$6,273,972—**Western Electric Co.,** Burlington, N.C., for continuation of work on *Nike-Hercules* air-defense guided missile system.

$4,000,000—**Texas Div. of Collins Radio Co.,** Dallas, for portable scatter communication terminals (AN/TRC-80).

$3,957,124—**Northrop Corp.,** Beverly Hills, Calif., for production of launchers for *Hawk* air defense system; $2,999,986 for production of warhead components for *Sergeant* missile; $2,571,529 for flight service for the *RP-76* target missile.

$2,917,800—**Bendix Corp.,** Ann Arbor, Micb. for ground-based electronic equipment fo Project *Advent* shipboard terminal.

$2,588,133—**Aircraft Armaments, Inc.,** Cockeysville, Md., for production of training devices for the *Sergeant* missile system.

$1,355,000—**Alco Products, Inc.,** Schenectady N.Y., for 7 diesel-electric generating units to produce "precise power" for Advanced Research Projects Agency's Pacific missile facility.

$609,000—**Bendix Corp.,** Detroit, for missile re-entry research being conducted at the Canadian Armament R&D Establishment.

$525,000—**Western Electric Co.,** New York City, for repair parts for support of *Nike Hercules* fault-locating indicators.

$497,000—**Talley Industries,** Mesa, Ariz., fo research, development, testing and production of 52 actuators for *Titan II* underground silo doors.

$438,000—**Babcock Electronics Corp.,** Costa Mesa, Calif., from **The Martin Co.,** fo airborne range safety receivers and support equipment for *Lacrosse.*

$294,395—**Twin Coach Co.,** Buffalo, N.Y., from **Raytheon Co.,** for electronic consoles fo the *Hawk* missile system.

$175,380—**U.S. Gauge Div. of American Machine & Metals, Inc.,** Philadelphia, fo precision switches for warheads of tactica missiles.

$130,780—**Raytheon Co.,** Waltham, Mass., fo concurrent repair parts for the *Hawk* missile system.

General Precision, Inc., Palo Alto Western Development Laboratory, from White Sands Missile Range, for design and construction of 8 ballistic camera synchronization units. No amount disclosed.

AIR FORCE

$11,158,000—**North American Aviation, Lo** Angeles, for *GAM-77A* air-to-surface missiles.

$9,000,000—**General Electric Co.,** Evendale Ohio, from **Thiokol Chemical Corp.,** fo development and manufacture of *Minuteman* first-stage solid-fuel rocket cases.

$2,500,000—**General Dynamics/Astronautics** San Diego, Calif., for three *Atlas* missile procedure trainers.

$750,000—**C&D Batteries Div. of Electric Autolite,** Conshohocken, Pa., for batteries t provide emergency power supplies t *Minuteman* ICBM weapon system.

$500,000—**Epsey Mfg. & Electronics Corp** New York City, from **The Martin Co.,** fo battery-charger power supply units fo the *Titan II* ICBM program.

$500,000—**Menasco Mfg. Co.,** Los Angeles from **General Dynamics/Astronautics,** fo titanium-alloy pressure vessels for *Atlas* ICBM and *Centaur* programs.

$492,000—**Thiokol Chemical Corp.,** Elkton Md., for continued research on high energy solid propellants.

$350,000—**Motorola, Inc.,** Scottsdale, Ariz., fo development and production of high power C-band pulse transponders fo Patrick AFB Missile Test Center.

$346,000—**Atlantic Research Corp.,** Alexandria Va., for development of new family o solid propellants having higher energ and performance characteristics.

$268,000—**Texas Instruments, Inc.,** Dallas, fo design and development of unattende marine seismic monitoring system.

$124,000—**Hughes Aircraft Co.,** Culver City Calif., from **Aeronautical Systems Div** for development of new plastic material and self-cooling techniques for missil exhaust nozzles for operation in extrem temperatures.

United Aircraft's Hamilton Standard Div Windsor Locks, Conn., for electrically driven hoists for work cages in the under ground launch sites of *Minuteman.* N amount disclosed.

—when and where—

JULY

Planning Aspects of Atomic Shelter, seminar, Pennsylvania State University, University Park, July 9-21.

Western Plant Maintenance and Engineering Show, Pan Pacific Auditorium, Los Angeles, July 18-20.

Structural Engineering Aspects of Atomic Shelter, seminar, Pennsylvania State University, State Park, July 23-Aug. 4.

AFOSR, Differential Equations in Nonlinear mechanics, cosponsored with Martin's RIAS, Air Force Academy, Colorado Springs, Colo., July 31-Aug. 4.

Physics of the Solar System and Re-entry Dynamics, National Science Foundation, NASA, Virginia Polytechnic Institute, Blacksburg, Va., July 31-Aug. 11.

AUGUST

Space Age Astronomy, sponsored by Douglas Aircraft Co., CalTech, Pasadena, Aug. 7-9.

American Rocket Society/Stanford University, Guidance and Control Conference, Stanford University, Palo Alto, Calif. (some sessions classified), Aug. 7-9.

Sixth Annual Technical Symposium, Society of Photographic Instrumentation Engineers, Ambassador Hotel, Los Angeles, Aug. 7-11.

Survival in the Nuclear Age—Executive Management, seminar, Pennsylvania State University, Aug. 13-18.

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letters

(Continued form page 4)

On Space 'Conservatism'

To the Editor:

It was appropriate, if accidental, that you should position "New Route to Cathay —Step by Step" (M/R, May 29, p. 37) immediately after "Science Takes Dim View of Man in Space." As if to add interesting emphasis to the not-so-subtle implication, you end a three-article sequence with "Booster Ideas Are Big and Varied" (could have been called "NASA Ideas Are Stunted and One-Tracked").

The first article describes a few "men" of science who, far from being dedicated to exploring new frontiers, are seeking to hide their fear of the unknown behind pseudo-scientific rationalization. Then along comes Mr. (Ralph) Cooper and sums up, in a delightful parody, the saga of what today might be termed "The Yellow American" or "The Role of Conservatism in Outer Space." In the third article we read of an exciting challenge flung by American enterprise at slothful NASA. Proven technology puts forth, in the true spirit of Columbus, concrete plans and real hardware with which the new Road to Cathay may be explored, only to be accused of over-zealous and exaggerated claims.

The situation was pregnantly packaged by Astronaut Shepard who, when asked by President Kennedy "What do you want to do next?", answered "Just let us go. We are being protected too much with equipment . . . (we want) to be free to explore space with less protection and more initiative and daring."

We should all rejoice that of such stuff astronauts are made. We should likewise mourn the fact that there are chicken-hearted Americans with tremendous "purse power" who very nearly cut Astronaut Shepard's booster out from under him.

Walter H. Trask
Lockheed Missiles & Space Div.
Sunnyvale, Calif.

Acronymizing

To the Editor:

I have a couple of suggestions for the Air Force regarding their quandary over the name *Saint* (M/R, June 12, p. 9).

First, for their critics they could substitute the code name *ASININE*, standing for Antisatellite Satellite INspection and INtercept Equipment.

Then, to provide the antithesis of the original name, they could go to *SINNER*, representing Satellite INspection and Navigated Equipment Recovery (although this is not quite correct technically).

Maj. Q. C. LaPrad
Ft. Bliss, Tex.

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editorial . . .

Thoughts on Non-Profit Firms

FOR SOME TIME, the U.S. military has been leaning more and more heavily on non-profit corporations for technical management and scientific evaluation. The House Appropriations Committee now has taken a roundhouse swing at those non-profit corporations in general and at Aerospace Corp. in particular.

In reporting out the Defense appropriation bill, the committee uses strong words to denounce contracts with non-profit organizations as a subterfuge to avoid the restrictions of civil service salary scales.

The committee demands that the Secretary of Defense come up with a realistic policy on the subject before presenting the next annual Defense estimates.

The Congressmen draw a specific bead on the newest of the non-profit groups, Aerospace Corp. They charge that the salaries paid by Aerospace are excessive, that its overhead costs are too high and that it plans to employ too large a staff.

The committee adds emphasis to its words by whacking a hefty $5 million off the budget request of $35,200,000 for Aerospace for Fiscal 1962.

"The Air Force should either be able to obtain its required services from Aerospace Corp. for $30,200,000 or find another method of coping with the problems involved," the committee asserts.

It is not our intent here to defend Aerospace Corp. from the committee's specific charges. But we would like to suggest that a more realistic appraisal would put the position of Aerospace and the other non-profit corporations in better perspective.

To denounce use of these corporations as a "subterfuge" for avoiding civil service salary restrictions is so much political hogwash. It is no subterfuge at all. It is quite frankly and openly one of the basic reasons why the corporations exist.

Management of today's weapon systems, evaluation of competitive technical proposals, requires talent of a level which cannot ordinarily be hired at military or civil service pay scales. To hire men technically competent to do the job requires salaries competitive with private industry. The non-profit corporations provide these.

For many years, industry was faced with a situation where the men evaluating competitive technical bids were far less competent than the engineers drawing up the proposals. Some bad decisions resulted. Use of the non-profit corporations has been, in part, an effort to remedy the situation—even if not a perfect answer.

There seems to be a general feeling in uninformed quarters that since the non-profit corporations do not have to pay dividends to stockholders, their earnings are distributed as largesse to officers and employes or in the form of magnificent expense accounts. This is not the case.

System Development Corp. for one, conducts frequent surveys of current salary scales in private industry to make sure its salaries are not out of line. Ask its president, Melvin Kappler, whether he could make more money elsewhere in salary and fringe benefits such as stock options. Ask the president of Aerospace, Ivan Getting, the same question.

IN 1959, a committee of outside scientists and industrialists was appointed by the Secretary of the Air Force to study the management needs of that service. Dr. Clark B. Millikan of California Institute of Technology headed the group. Its primary task was to study the relationship between the Ballistic Missile Division and Space Technology Laboratories. While finding that the time had come to modify the arrangement in relationship to STL, the Millikan committee acknowledged that the Air Force had to have, in some form, access to the kind of high competence supplied by STL.

Aerospace Corp. was the answer.

"Essentially, this corporation will be people—people of the highest quality," the Secretary of the Air Force said at that time.

It takes competitive salaries to attract people of that quality from private industry. The sooner the Appropriations Committee acknowledges the fact, the sooner it will come to a realistic appraisal of the problem.

There are areas in which Aerospace and the other non-profit corporations should be watched closely. They have a tendency to over-expand. In certain fields, they compete with private industry.

The Millikan committee asserted that detailed development-systems engineering and detailed technical direction of specific missile/space projects should be the responsibility of normal competitive industry. Congress should make sure this recommendation is followed.

But sweeping condemnations of the non-profit institutions, such as the House Appropriations Committee has just made public, do a disservice to the nation.

William J. Coughlin



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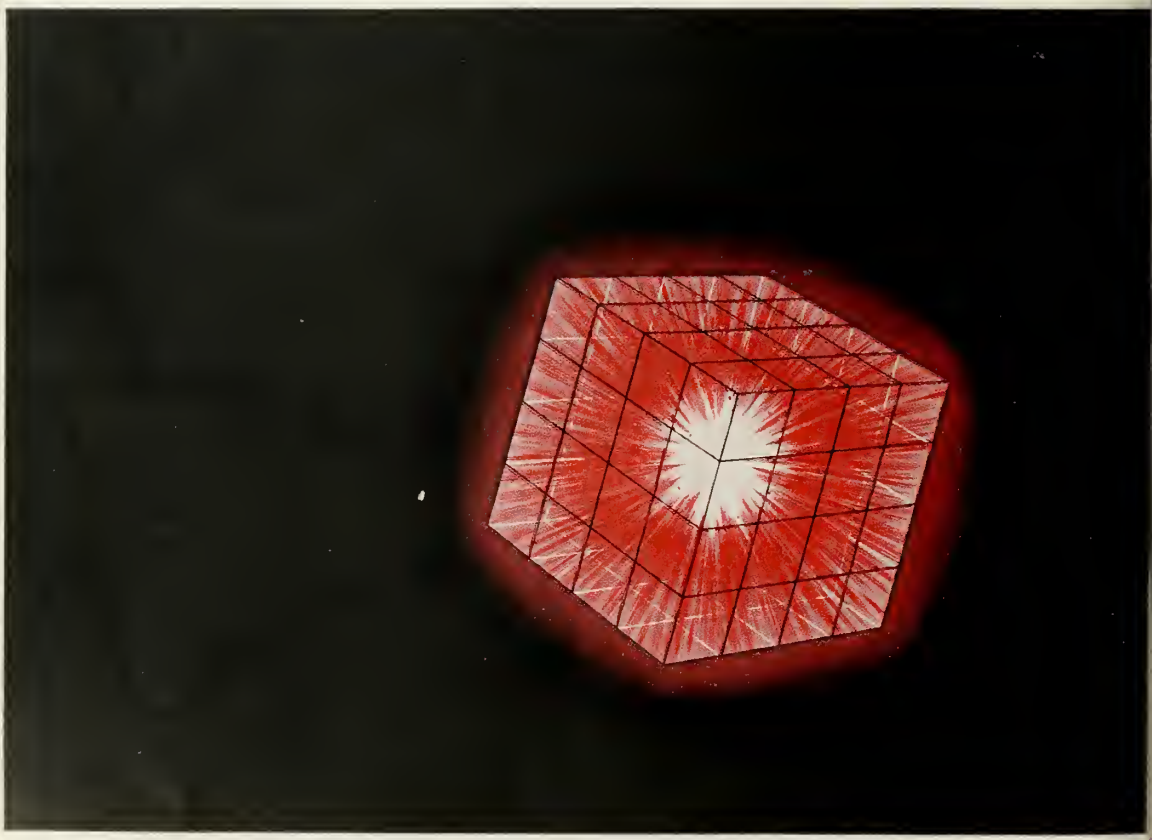
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missiles and rockets

THE MISSILE/SPACE WEEKLY

Houston Texas



SNAP Generator Fastened to Transit IV-A

New Era Dawns for Nuclear Space APU's .
Laser Seen Replacing Radar Navigation .
A Satellite Test of Einstein Theory? 32

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CENTRAL DATA PROCESSOR for AIR TRAFFIC CONTROL

Today, at a peak traffic hour, approximately 200 aircraft flew over the New York area. Each year this number will increase. Yet, the Federal Aviation Agency will continue to assure safe and efficient control of air traffic. One reason . . . a data processor developed for the FAA by Librascope to quickly and accurately handle the routine clerical tasks now occupying most of the controller's time. The first 18-unit data processor will be installed at Boston in 1962. A note to Librascope outlining your control problems will bring a prompt answer from the country's most versatile manufacturer of computer control systems.

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Is Defense Advertising Necessary?

There has been a lot of talk lately about the cost of the advertising done by defense contractors. One prominent Senator recently said he was greatly disturbed over heavy defense advertising expenditures. He pegged the cost "to the taxpayer" at $500 million.

This figure is many, many times the actual total of defense advertising expenditures and only a fraction of that total is recoverable. The Senator's facts are wrong; but, even more disturbing, it appears that he doesn't understand the purpose and function of sound advertising. He considers this money down the drain and thinks it should not have been spent.

There are other instances demonstrating a growing wave of anti-advertising sentiment in high government places. They indicate a lack of understanding and represent a threat both to freedom of the press and success of the Nation's defense goals.

We publish specialized business magazines and reference books. Several of these are defense oriented. They perform communications functions essential to our national goals . . . more essential now than ever before because of the complexity of today's technological and political challenges. There are other excellent magazines having the same or similar purposes. We're delighted—because competition is healthy and because there is more to be done than can be handled by any one of us.

Virtually all publications are financed, by and large, by advertising. This is healthy, too; but it is not the primary reason for defense advertising.

We believe that advertising is an effective and necessary tool for the defense contractor. The objectives of defense advertising are many: some of them obvious, others more subtle.

Sales is one obvious objective. It can be demonstrated that advertising, for some defense products, has led directly to sales. In other instances, selling is a long, complex process, where features of current products may not be as important as company reputation. In both cases, the government wants competition for defense contracts—by use of a competitive bidding system, it gets better products for less money. How is a company to compete if it is not allowed the use of sales tools—one of which is advertising?

Recruiting is another obvious objective. Will that engineer who is inspired to contribute to technological advancement in the missile/space age, for example, be interested in learning more about the kind of company he goes to work for? You bet he will, and more power to him.

The dissemination of technical information is a third, and perhaps the most important, objective. The exchange of such information is one of the biggest problems facing both government and industry. And what more effective, more economical means of disseminating necessary technical information exists than the business press? Mills Shepard, who performs readership studies on one of our publications, reports that advertisements are often read as avidly as the editorial pages. And Eastman Research, in a study released May 29, based on more than 100 surveys for 32 business-paper clients over a two-year period, reports that *70% of the readers interviewed read the advertising in these businesspapers on purpose.*

There are many other equally important objectives. Companies must raise capital in order to be able to do the jobs that need doing for defense. Good community and employee relations are considered necessary to a company's well-being. These and other objectives have been effectively achieved by defense contractors through advertising.

The defense industry is made up of numerous private companies facing the tremendous challenge of meeting, in cooperation with the government, our national technological goals. To meet this challenge, the companies must be strong and healthy. To deprive them of the use of effective and honest advertising is shortsighted and wrong.

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How the ocean grew "ears" to pinpoint missile shots

A quarter of the world away from its launching pad an experimental missile nose cone splashes into the ocean.

How close has it come to the target?

Where can it be found, recovered and studied?

To answer these questions quickly and accurately, Bell Telephone scientists have developed a special system of deep-sea hydrophones—sensitive "ears" that hear underwater. Its name—the Missile Impact Locating System, or MILS for short. MILS, produced by Western Electric, manufacturing and supply unit of the Bell System, involves two types of networks.

- One is a Long Distance network which monitors millions of square miles of ocean. The nose cone releases a small bomb which sinks and explodes at optimum depth for transmission of underwater sounds. Vibrations are picked up by hydrophones stationed at optimum depth and instantly carried by cables to ground stations. Since the vibrations take longer to reach some hydrophones than others, time differences are measured to compute the location of the nose cone.
- The other is a "bull's-eye" network which monitors a restricted target area. This network is so sensitive that no bomb is needed. It can detect the mere splash of an arriving nose cone and precisely fix its location.

MILS is now operating in both the Atlantic and the Pacific test ranges. It was installed by the U. S. Navy with technical assistance from Western Electric.

It's still another example of how the universe of sound—below the sea, above the earth, in outer space—is constantly being explored by the Bell Telephone System.

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THE MISSILE / SPACE WEEKLY

missiles and rockets

Volume 9, Number 2 July 10, 1961

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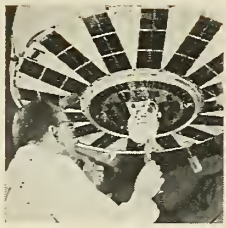
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THE COVER

Tiny SNAP generator is fastened to base of Transit IV-A satellite prior to launching June 29. Nuclear powerplant was built by Martin under AEC contract. See p. 12.

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letters

Emphasizing Quality

To the Editor:

I have just read your editorial, "A New Emphasis on Quality," in M/R, June 26. It is gratifying to know that a respected magazine is expressing concern over the procurement problems which beset defense spending.

As you know, I have been involved in defense procurement since the beginning of World War II; and I am thoroughly convinced that in order to practice economy, it is essential for us to consider total cost over the entire useful life of our weapons systems.

I appreciate the fact that you included some of my remarks in your editorial.

W. A. MacDonald
Chairman of the Board
Hazeltine Corp.
Little Neck, L.I., N.Y.

To the Editor:

I want to compliment you on your editorial, "A New Emphasis on Quality." It was excellent.

H. Thomas Hallowell, Jr.
President
Standard Pressed Steel Co.
Jenkintown, Pa.

To the Editor:

I liked your editorial, and wish to offer a vote of applause from the standpoint of an operator of military equipment.

As missiles, aircraft, ships, weapons and electronics have increased in complexity, the reliability curve has dropped. The answers have included "jury rig" solutions such as providing not only the hardware but a bevy of scientists to go along with the equipment and baby it along (and at great expense). This can never be the way to fight under actual combat conditions.

Another consequence of deteriorating reliability has been the frantic efforts by the military to increase the educational level of officers. This, while helpful, can never be a panacea.

Industry, DOD and the operators should be of a single philosophy, namely that hardware must be 100% reliable, or it is of no value militarily. Defining what 100% reliability amounts to would be a challenging task, however (considering conditions which exist during actual conflict), this philosophy should stand up.

Another factor bearing on the subject is that the military "operators" are average Americans—not geniuses. This will be so as long as the economic climate of the country remains so prosperous. Most very-high-level engineers are lured by the opportunities represented by the multi-page want ads in papers like the *New York Times*—under the heading "Engineers." Equipment, therefore, must conform to the capabilities of the operator on an instantaneous response basis . . .

Capt. J. E. Hart, USN
Monterey, Calif.

Life Support at AMF

To the Editor:

Your article entitled "Life Scientists Demand Top Priority" (M/R, May 29, p. 44) in the special issue on Man-in-Space was read with great interest by our staff.

While we certainly agree that there is a need for more emphasis on the development of advance life-support systems, the picture is not as black as depicted in your article. As was shown at the 32nd annual meeting of the Aerospace Medical Association in Chicago this spring, several companies including American Machine & Foundry have developed the technology necessary to build advanced life-support systems.

We do not agree that (1) "insufficient emphasis has so far been placed on the requirements of human occupancy for long-duration voyages," (2) "a satisfactory approach to development of life-support equipment has not been taken . . .," or (3) "the lead times for life-support systems are much longer than for other systems and the present lack of effort is really going to hurt."

The Air Force and NASA are sponsoring work to obtain flight prototype systems for gas conditioning, oxygen regeneration and water recovery. When an actual requirement exists for a specific vehicle, qualified systems can be developed in less than two years. A very good approach has been adopted for developing these systems, namely, environmental simulators as used by the School of Aviation Medicine, Aerospace Medical Division of ASD, and the U.S. Navy Air Crew Equipment Laboratory.

During the past year we have assembled an automated experimental model of an integrated life-support system capable of servicing three men on extended missions. All the analysis and laboratory test necessary to verify the feasibility of this system has been performed. We are now concerned with improving the maintainability of this system, which contains a catalytic burner, regenerable CO_2 and odor removal station, reactor for reducing CO_2 with hydrogen, electrolysis unit for generating oxygen, and a compression distillation water recovery component. This approach imposes the least mass and power penalty of any "closed" water-oxygen system known today, and should satisfy all manned space-flight environmental requirements for the next 10 to 20 years . . .

R. A. Bambanek
J. D. Zeff
American Machine & Foundry Co.
Niles, Ill.

The remarks quoted in the third paragraph of the above letter were made not by M/R but by industry experts. The less-than-two-years' lead time required, according to Messers, Bambanek and Zeff, for development of qualified life-support systems for "actual requirements" seems to us to be a substantial length of time and

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o underline the urgency of acquiring bet-er knowledge of radiation and weightless-ness as soon as possible.—Ed.

Saturn by Dirigible

To the Editor:

An article in the June 12 M/R (p. 16) eports that the collapse of one of the ocks on the Tennessee River will probably elay the September firing of the *Saturn,* s this blocks the transportation of the *Saturn* via barge from Huntsville to the Cape, and that officials are frantically earching for other means of transporta-ion.

Last November an all-metal, stressed-kin airship was proposed to NASA and he Army Transportation Corps. The ship, lesignated the SMD-100, has been brought o NASA's attention numerous times in he past eight months, but with the same eaction each time, as per the enclosed etter signed by Maj. Gen. Don R. Ostran-ler, the consensus being (prohibitive) cost. May I suggest that, where we are dealing vith the 17,000-mph missile and are push-ng it around in a barge at 3-knots-per-our, it is vaguely reminiscent of the first ircraft purchased by the Army—which ad to be designed so that it could be arried on a standard Army wagon.

This means of moving missiles or aunching pads or any other heavy equip-nent that would be impossible to move y any other known surface method was ot offered for sale to the government or ny other agency. This offer was made to nove any of the above-named items trictly on a weight-mileage basis or a ontract to move any time, any place, ither full- or part-time. We have had a umber of inquiries from commercial irms, some in foreign countries, in regard o using this equipment to move perish-ibles and various other things. This equip-nent would be built and owned by private nterprise, will be classed as a common arrier such as any steamship or any reight carrier or other methods of trans-ortation. Actually, to move the entire *Saturn* unit from Los Angeles to Florida nd back, which is your portal-to-portal on quipment of this order, would be roughly 50,000 and would be completed within 4 hours.

So you see that the General's letter uoting total costs is not exactly true be-ause the development and operation of his unit doesn't enter into any part of any ontract. During the war, the government eased large passenger ships for troopships rom the various steamship companies, and his would operate on the same principle or the exclusive use of this ship for a hree-year period. It could be used not only or missile deliveries, but for any other eavy equipment to be moved anywhere n the world. In closing, I would like to sk a question: If, with the present equip-nent, we can't move the *Saturn,* how are ve going to move the *Nova?*

C. W. Farrar
Executive Director
Associated Specialists Inc.
Los Angeles

Editor's Note: Gen Ostrander's letter tated that use of dirigibles to transport Saturn stages cannot compete economically with water transportation, due primarily to the fact that initial Saturn stage production rates are too low to utilize the total transportation capacity of such a vehicle. Gen. Ostrander estimated total costs, both developmental and operational, for the proposed dirigible, amortized over 5 years, at five times those of water transport. Associated Specialists Inc. estimates cost of the first dirigible at $15 million, second at $8 million, and others at $6 million each.

Ivy and Missilery

To the Editor:

Congratulations on "New Route to Cathay" (M/R, May 29, p. 37). Mr. Cooper's well written simile to our man-in-space program is both amusing and disturbing. The astonishing lack of understanding of the urgency for a sound and practical space program seemed as far beyond the capacity of the Eisenhower Administration as the need for large rocket engines and ballistic missiles was to Truman's. What President Kennedy's position will be is not yet clear in my mind.

Since the launching of the first Soviet satellite vehicle, one factor has become increasingly clear. High-level scientific advisers to the Administration and government agencies have, in a large part, been drawn from university teaching and administrative staffs. These people have subsequently been dubbed by the public relations men "missile experts" or "space experts." Like many others who were associated with the missile/space effort in the years prior to *Sputnik I,* I have searched my memory and files for any evidence of work performed by these people in the areas in which they are now assumed to be experts. I find none.

There is, however, increasing evidence that these people are bringing with them from the campus every pet academic project for which they could not acquire support at their university research institute.

To date, what success we have enjoyed in our missile and space programs has been the result of good engineering practice making use of existing scientific knowledge. For what we could have done, those in government have only to dust off old proposals submitted in the years when there was "no requirement for large rocket engines" (1947-1953). Now we have a different situation. Our former teachers are leaving the hallowed halls and want to research any and everything to death. Left to these people, we might still be "optimizing the plowshare." Time after time we hear the cry, "the Soviets are doing it, so must we."

Just a few weeks ago I had occasion to speak with the director of a large university research activity who has had considerable contact with Russian scientists in his field of work. He mentioned that they use the same technique to gain government support for their pet projects.

The needle that prompted this letter was your article, "Life Scientists Demand Top Priority," just a few pages behind Mr. Cooper's. This program sounds very much like the beginning of one of the bigger and better boondoggles which have come to light in recent years. Let's keep professors in universities, working scientists in the laboratories doing basic research, and leave the hardware development to engineers.

How you replace university presidents whose recent experience is fund-raising for a new library with people from industry who know and have worked with our technical problems for years is beyond me. Perhaps the government public relations people find that they don't have the proper public "image."

J. S. Tillman
Sunnyvale, Calif.

'Incredible' Misspelling?

To the Editor:

In M/R, April 3, p. 36, there is a paragraph:

"The program includes an observation of Venus by *astronomer* A. Doll*fuss* from a high-altitude (80,000 ft.) point where he will be taken by a 'grape' of 30 balloons."

Dr. Audouin Dollfus is an astrophysicist, not an astronomer, and the name is spelled with one, not two, s's. I realize that most of these errors occurred in *Shell Aviation News* of November, 1959, which shows photographs of the apparatus and of Dr. Dollfus and his father, Charles.

It would seem to be inexcusable in the Shell organization to have the name misspelled. To mispell it in a semi-scientific publication is incredible. If the item as indicated came from Paris—there it is completely incredible, where everyone knows the family and they can be checked in the local directories. Although now retired, Charles Dollfus is editor of "Histoire de L'Aéronautique" (as well as the companion volumes of histories of railroads, steamships, automobiles).

The surname might, of course, have been changed to the German form with two s's, but this seems to me unlikely. When Dr. Dollfus was here in the USA for nearly a year recently on astrophysics exchange work, I never saw his name incorrectly spelled by the *New York Times* or any of the publications of the American Institute of Physics. I cannot remember its ever being wrong in Science Abstracts-Physics.

Pearl I. Young
Lancaster, Pa.

Suggested Reading

To the Editor:

I would like to recommend to everyone the book "America: Too Young to Die," by Maj. Alexander P. de Seversky (McGraw-Hill Book Co., Inc.). This book is a shocking criticism of our defense program, and it calls for a vast reorganization of our defenses to avoid destruction.

There is a 16-page condensation of the book in the July issue of *True* magazine.

Again I urge you to revive M/R's "Countdown for Survival" to help prevent our destruction.

David W. Johnston
Washington, D.C.



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The Countdown

WASHINGTON

ICBM's—Where Do We Stand?

Searching closed-door hearings into U.S. strategic missile capability will be conducted this month by the Senate Preparedness Investigating Subcommittee. Major questions concern the availability, reliability and operational readiness of *Atlas, Titan, Minuteman* and *Polaris* along with *Skybolt* and *Hound Dog* and the "mix" of these missiles with bombers. The subcommittee also wants to know why Defense Secretary McNamara is stopping at the 29th *Polaris* submarine.

ComSat—Decision in Making

President Kennedy's National Aeronautics and Space Council is meeting this week to come up with recommendations on the communications satellite program. Betting now is that it will favor NASA R&D participation in a commercial satellite through Project *Relay*. But how the ownership question will come out is still up in the air. The FCC, incidentally, vacations in August. If an Administration decision isn't forthcoming on how many and what companies should own the venture, the FCC may not be able to act until September.

Non-Profit Inquiry Starting

The House Space Committee is taking its inquiry into DOD's non-profit "think" corporations off the backburner and will hold hearings late this month. Reason: congressional ire stirred up by reports of high salaries and unnecessary expenses run up by the corporations. Insiders are saying, however, that the investigators will find the headline pickings pretty slim—preliminary findings have unearthed practically nothing of a sensational nature.

Lunar Exploration Reshuffle

There are indications that NASA is considering a major overhaul of its *Ranger, Surveyor* and *Prospector* programs to speed them up. Several companies are offering proposals for modified lunar soft-landing packages. They are designed to get information about lunar conditions quicker, so that the data can be pumped into the *Apollo* program.

On the Pad

Following up the shot this month will be a third *Mercury Redstone* manned suborbital flight in August. Also next month, another try at orbiting an unmanned *Mercury* capsule aboard an *Atlas*. It will be followed in September—if successful—with an attempt to orbit a primate. Other NASA shots: a *P-32 Ranger* lunar payload with an *Atlas-Agena* about July 28; an *S-3* energetic particle satellite and an *S-55* micrometeorite satellite in August.

INDUSTRY

Astropower A-building

Douglas Aircraft's Astropower Inc. subsidiary is occupying an 85-acre site south of Los Angeles under a lease-option agreement. Testing is expected to begin in August at a test site built by the owners. Astropower is to get occupancy next May of new 40,000-sq.-ft. building.

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NASA's Patents—No Change

Although the House Space Committee may vote out a bill to bring NASA's patent policy in line with DOD's, the legislation isn't expected to pass Congress. Senate Space Committee, it's reported, will go along with NASA Administrator Webb's stand that no changes are needed at this time.

Kiwi-B on the Move

Rover nuclear rocket program's *Kiwi-B* reactor is being taken piecemeal from Los Alamos and reassembled at the AEC's Nevada Test Site. First hot run of the highly automated test unit is due in October.

R&D Intelligence

Using Curium 242, some nuclear physicists now feel, can upgrade the output of a *SNAP* unit to 30-40 watts. . . . NASA is being attacked on its request for $60 million to build a new space flight lab. One congressman says it's an open invitation to "raid" other biomed agencies. . . . Solid-propellant men are contending that the biggest obstacle to constructing megapound-thrust solid boosters will be in developing the proper motor cases. . . . Newly de-mothballed and outfitted ($30 million) American Mariner ship for Project DAMP (Downrange Antimissile Measurement Program) is now on her shakedown cruise.

Autonetics Shifts 5000

North American's Autonetics Division has wound up the transfer of its Computer and Data Systems from Downey to East Anaheim, Calif. Relocation involved 5000 personnel.

INTERNATIONAL

European "Space Club" Set

West Germany has agreed in principle to participating in a European cooperative satellite launching program costing some $200 million over the next five years. This removes the last apparent obstacle to formation of the "Space Club," which hopes to orbit satellites up to one-ton with a three-stage vehicle based on the British *Blue Streak* IRBM. Britain's share of the cost is to be one-third. Participating nations are expected to lean heavily on U.S. missile/space industry know-how to get the program rolling.

Overseas Pipeline

Launch of Israel's first sounding rocket—the *Shavit II* —is believed to have been from a site at Mt. Carmel. . . . Labor problems are still dogging construction of the British BMEWS station on Fylingdales Moor. . . . There's word that Britain is leaning toward purchase of Nord's *AS-30* air-to-surface missile.

Wary Eye on Woomera

Red Chinese nuclear technicians are reported staffing their Djakarta, Indonesia, embassy—apparently to keep a wary eye on British Vulcan bombers conducting drop tests with the *Blue Steel* stand-off missile in the Woomera Missile Range.

Israel's Rocketry Debut

Israel became the seventh country to study the weather with rockets when it successfully launched *Shavit Shtayem (Meteor II)* 50 miles into the ionosphere.

The multi-stage, solid-fuel rocket exploded a cloud of sodium at its maximum height to permit observation of prevailing wind conditions. No telemetering equipment was carried, official sources said.

Launching place was secret, as was the exact number of stages comprising the rocket. Total weight was given as from 550 to 660 lbs.

Other countries with meteorological rockets: United States, Soviet Union, France, Great Britain, Italy and Japan.

Shots of the Week:

An attempt to gain more data on the micrometeoroid picture failed June 30 when the third stage of a NASA *Scout* vehicle exploded in flight.

The vehicle, which reached an altitude of about 70 miles, carried a 187-lb. satellite instrumented to measure the micrometeoroid hazard in space. It was launched from Wallops Island.

The Navy's *Transit IV-A* was still working perfectly after a three-in-one satellite launch from Cape Canaveral June 29. The two other satellites, a 55-lb. *GREB* and a 40-lb. *Injun,* failed to separate and are in orbit together. (See p. 12.)

"Technical difficulties" caused the last-minute scrub of an Air Force *Midas* satellite launch July 2. The satellite was to have been launched at Point Arguello.

NASA to Launch for A.T.&T.

NASA will sign a contract before the end of this month to launch an experimental communications satellite developed and built by the American Telephone and Telegraph Company.

Under the agreement, NASA will provide the launching facilities, the launching rocket and network for tracking the satellite in orbit. A.T.&T. will reimburse the government for the cost of the launching.

The phone company will also be subject to supervision by the government and—as NASA officials put it—the experiment will be integrated into the government's program for development of a communications satellite system.

The A.T.&T. proposal is to build an "active repeater" satellite which would weigh about 130 lbs. and be placed in a 5000-mile orbit.

Nuclear Weather Man

The world's first atomic-powered automatic weather station soon will be shipped from The Martin Co. for operation in a remote location in the Canadian Arctic regions.

The unit, capable of transmitting temperature, wind speed and barometric pressure up to 1500 miles, derives its power from pellets of strontium-90. Heat is transformed into electricity by thermoelectric couples and stored in rechargeable batteries.

The elements and electronic components were produced by The Martin Co., and fueling was carried out by the Atomic Energy Commission's Oak Ridge National Laboratory in Tennessee.

L-T/CV Merger Okayed

Ling-Temco Electronics and Chance Vought stockholders have approved merger of the two companies into Ling-Temco-Vought, Inc. It will come into being Aug. 31 with assets of over $194 million and a $300 million backlog of orders. CV will be re-established as the aerospace subsidiary of LTV.

Robert McCulloch will be board chairman and chief executive officer, the position he now holds with L-T. The Justice Department meanwhile is looking into any possible antitrust violations in the merger.

Haymaker Heads NASA Lab

NASA has appointed Dr. Webb Haymaker Assistant Director for Life Sciences at the Ames Research Center, Moffett Field, Calif., and Di-



Plug Nozzle Mockup

GENERAL ELECTRIC is using this mockup for engineering studies on its plug-nozzle rocket engine propulsion concept. Nozzle would be used on 2.5-million-lb.-thrust engine. GE is now testing a 50,000-lb.-thrust plug-nozzle engine.



Radioplane's New Target Drone

LUNEBERG LENS LUGGING expendable RP-76 target aircraft is currently undergoing demonstration tests at Point Mugu for possible use as a fleet training target. The solid-propellant drone, developed by Radioplane, recently set an altitude record for unmanned aircraft—74,000 ft.

rector of the Life Sciences Laboratory.

The laboratory will conduct research in the three main divisions NASA has designated in the life sciences: space medical and behavioral sciences, space biology and biotechnology.

Dr. Haymaker is a neuropathologist, specialising in ultrasonic and ionizing radiation effects, decompression sickness, heat stroke, hypozemia (deficient oxygenation of the blood) and neuroanatomy.

Biggest High-Vacuum Chamber

Lockheed Missiles and Space Co. will begin testing space vehicles this fall in its $1.6-million high-vacuum orbital simulator just installed at Sunnyvale.

The stainless steel cylinder, largest known high-vacuum chamber, will be used primarily to test Lockheed's *Agena* spacecraft.

The 75 ton chamber is 20 ft. high and 18 ft. in diameter, with foot-thick walls. It will simulate altitude up to 200 miles and has a temperature range from −200°F to +320°F.

Johnson Nears Confirmation

Dr. Gerald W. Johnson, nuclear weapons testing expert, has been tentatively approved as chairman of the military liaison committee serving the Atomic Energy Commission.

Appointment of Johnson, who is associate director at Lawrence Radiation Laboratory, was approved by a Senate subcommittee. He has promised, if confirmed by the Senate, to cancel two private industry contracts he holds as a consultant.

Marshall Set to Expand

Marshall Space Flight Center's budget will double—to over $800 million annually—if Congress passes NASA's Fiscal 1962 budget requests.

Dr. Wernher von Braun, director of the facility, also told a "Space Day" banquet at Huntsville, Ala., that the center plans to hire 1000 more employes during the current fiscal year.

NAA Studies Rendezvous

North American Aviation's Space and Information Systems division is developing mathematical techniques to provide mechanics for satellite rendezvous under a new NASA contract.

Some of the aims of the program are to provide basic formulas for rendezvous, and to determine the best way to move a vehicle from one orbit to another with minimum use of fuel. The contract, for 15 months, is based on work North American did under a previous NASA contract.

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Era of Nuclear Space APU's Arrives

Fears of adverse reaction prove to be unfounded; way may be clear for flights of U.S. nuclear rocket engines

by Hal Gettings

MORE NUCLEAR power sources are to be flown in space soon—in both lunar and planetary probes as well as future *Transit* navigation satellites.

Some government officials are privately predicting, moreover, that the successful orbiting of a grapefruit-sized SNAP-3-type unit aboard *Transit IV-A* June 29 will ease the way for flight-testing of nuclear rocket engines.

Almost complete public indifference to the placing of the isotopic power source in orbit is being regarded in Washington as a political breakthrough of sorts. It also was ample evidence that official fears of international reper cussions—fears that have delayed th flight of nuclear power devices for mor than a year—were unwarranted.

Officially, the Atomic Energy Com mission is denying there was a delay claiming the time was used to make th unit 100% safe. But the State Depart ment is known to have opposed the ide on grounds it might upset nuclear tes ban negotiations with Russia and out o fear that an aborted launch might dro a radioactive source on foreign soil.

In any event, a new era of nuclea power sources in space appears to hav dawned.

They are now expected to be de signed into the *Surveyor* lunar soft land ing vehicle, go aboard the *Marine* spacecraft which will fly-by Venus, an be used in the operational *Transit* satel lite. The Air Force may revive a plan to put them aboard *Discoverer*. (It had planned to use two 125-watt SNAP I-A units, but this unit was turned into a test bed.)

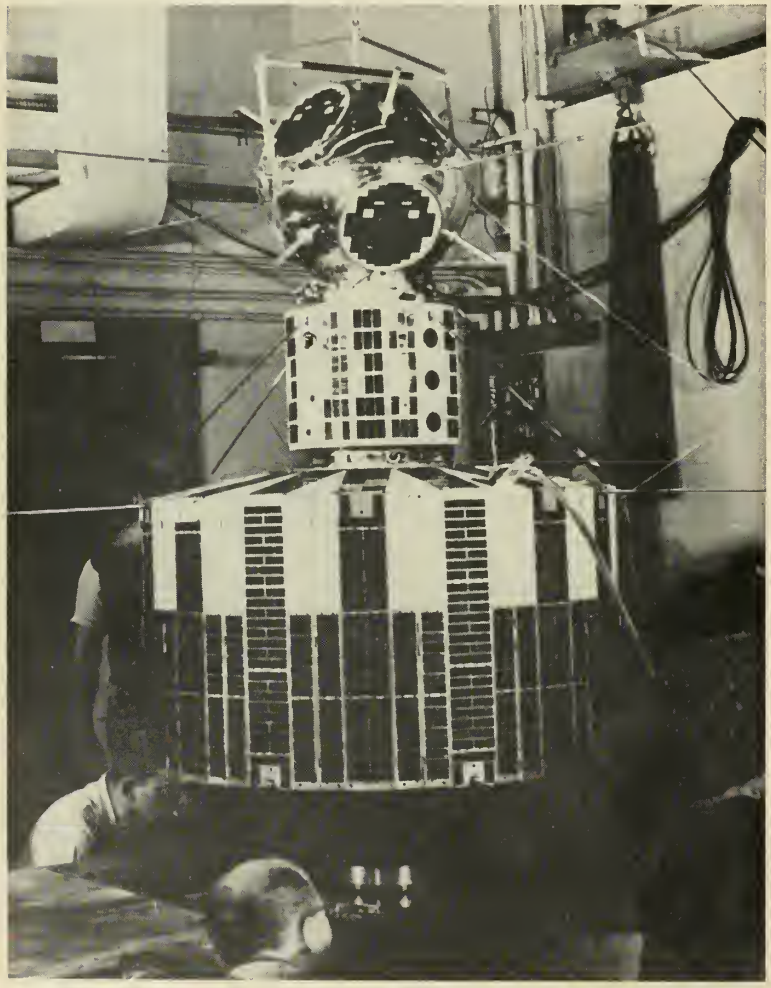
• **Time reference**—*Transit* program officials said last week signals from *IV-A* were being received clearly at all their tracking stations. They said the distortion-free signals in an operationa system in addition to providing highly accurate navigational reference coul also provide an extremely accurate world-wide time service.

The only fault in the launch was the failure of two piggyback satellites *GREB III* (to measure solar X-rays) and *Injun* (to measure radiation of the Van Allen belt), to separate. They were transmitting signals, but some of the instrumentation was unable to function properly.

All three satellites were in a 629/ 550 statute-mi. orbit with a 104-min period.

The unnumbered SNAP generator used in *Transit* differs only slightly from the SNAP-3. Biggest difference is in the use of plutonium-238 as the heat-generating isotope rather than polonium-210.

Plutonium-238 is primarily an "alpha" emitter (the least penetrating of the three types of radiation) so that the generator requires no shielding at all most of the energy of the alpha particles is used to produce heat within the device. Also, its relatively long half-life



MATED SATELLITES were checked out prior to shipment in environmental test laboratory at Applied Physics Laboratory of Johns Hopkins University. GREB-III is sphere at top, Injun in center, and Transit at bottom of three-satellite stack.

(about 90 yrs.) offers maximum advantage over other types of power supplies.

The plutonium-238 isotope cannot support a chain reaction. Even in large masses, it presents no danger of atomic explosion.

The most hazardous aspect of plutonium is that all forms are poisonous if inhaled or ingested by living organisms. Consequently, the fuel of the SNAP generator must be enclosed in a manner which will prevent its accidental release. Martin Co., under AEC contract, undertook an exhaustive series of safety analyses and tests to demonstrate this design characteristic.

The SNAP unit in *Transit IV-A*, built by Martin Co., furnishes power for some of the satellite's instrumentation as well as that for two transmitters. The first signals from the satellite came from the nuclear-powered transmitters.

The unit is expected to last for five years or more. It weighs about one-fifth of an equivalent battery-solar cell system. In addition, it operates continuously, not depending on sunlight for energization.

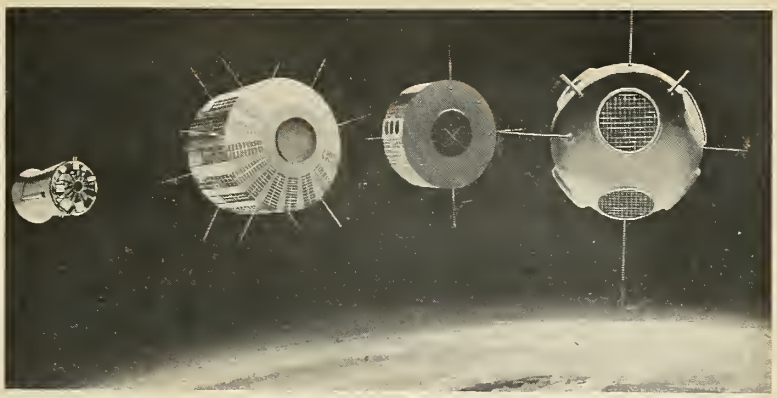
AEC will not name the thermoelectric material used to convert the nuclear heat directly to electricity. They say it is one of the most efficient developed to date.

Transit IV-A is the fourth in a series of satellites in the Navy's program to develop an all-weather, world-wide navigational system.

The satellite weighs 175 pounds. It is a polygon with a flat top and bottom and 16 sides. It is approximately 43 inches in diameter and 31 inches high. It has an improved memory system including an absolute time system which will periodically receive orbital data from a ground injection station. The satellite will transmit this orbital data continuously until new data is received from the ground to replace the old.

From a single passage of the satellite, a properly equipped station on the ground will be able to compute its own position from the orbital data and the shift in the apparent pitch of the satellite's signal due to the Doppler effect. The satellite is powered by solar cells and carries two nickel-cadmium batteries in addition to the SNAP generator.

The *Transit* system is being developed by the Applied Physics Laboratory of the Johns Hopkins University for the Bureau of Naval Weapons. The Forest Grove facility of APL at Silver Spring, Md., serves as the data injection station. The APL field station at Howard County is the primary tracking station. Other ground tracking stations are located at the University of Texas (Austin); the University of New Mexico (Las Cruces); and at various overseas locations. Naval Ordnance Test Station, China Lake, Calif.; Naval Weapons



BOOSTED BY THOR-ABLESTAR, Transit IV-A carried two hitchhikers which failed to separate after going into orbit. Left to right: Ablestar upper stage, Transit, Injun and GREB. Satellites are not shown here in accurate proportion.

Laboratory, Dahlgren, Va.; Bureau of Ships; and the Pacific Missile Range are also participating in the *Transit* development program.

Transit has chalked up a record of four successes in six tries.

The first successful *Transit* satellite, *1-B*, went into orbit April 13, 1960. It was also the first satellite to demonstrate the technique of separating a pickaback vehicle into a separate orbit. It carried a metal disk which was separated from the satellite by the same type of device used with later piggyback satellites. *1-B* is now silent due to failure of a thermal switch.

Transit II-A was launched June 22, 1960. It is still transmitting signals, but only when the satellite is in sunlight; an exploded storage cell prevents it from storing energy to operate in the dark. *II-A* was the first satellite actually to carry a piggyback payload, the NRL GREB-I. Data obtained from *1-B* and *II-A* are being used in studies of the earth's size and shape and in other geodetic studies. They also are being analyzed to determine the effects of sunlight on drag.

Both *1-B* and *II-A* responded to command signals from the ground. Both also demonstrated the practicability of mechanical and magnetic de-spin devices which reduced satellite rotation in orbit.

Transit III-B was launched February 21, 1961, along with the NRL *Lofti*. Because of a malfunction in the launching vehicle, the satellites did not separate but orbited together with the second stage of the rocket. They re-entered the atmosphere and burned on March 30, 1961.

• **GREB-III**—Solar Radiation Satellite III *(GREB)* will provide a continuation of measurements begun in June, 1960, with the *GREB-I* satellite. Although externally similar, the latest *GREB* embodies modifications based on results obtained from the first satellite. Its 20-in.-diameter aluminum shell carries six 9-in. solar-cell patches. Electronic equipment is housed in a 12½-in.-diameter in the center of the 55-lb. sphere.

The purpose of the *GREB-III* is to measure the level of X-radiation from the sun. X-rays are emitted in greater quantities during solar storms, producing changes in the ionosphere which cause considerable disturbance to radio reception on earth.

Several improvements over the 1960 satellite experiment are incorporated in *GREB-III*. Since the ultra-violet radiation of the sun is relatively constant even during solar storms, the new experiment will monitor the sun with two X-ray detectors instead of with one X-ray and one ultraviolet detector.

• **INJUN**—The *Injun* satellite was designed and built by Dr. James Van Allen. Its purpose is to measure the intensity of cosmic radiation, especially in the inner and outer Van Allen belts, and to investigate auroral phenomena in both the Northern and Southern hemispheres.

Specifically, it is designed to make the following measurements:

—Detailed plotting of the auroral zones.

—Simultaneous plotting and monitoring of the Van Allen outer radiation zone.

—Monitoring of cosmic rays and solar protons over a wide range of magnetic latitudes.

—Measurement of charged particles trapped in both the inner and outer Van Allen belts.

—Measurement of particle downflux from the equator to auroral zones, together with simultaneous observations of airglow and auroral emissions, and subsequent correlation with phenomena measured at several ground stations in the U.S. and Canada.

—Study of both particle and light fluxes associated with the detailed structure of aurora. ⁂

NASA Plans Polar Orbits from PMR

by Hal Taylor

SEVERAL NASA satellites will be launched into north-south polar orbits starting next year—setting off a new surge of activity on the Pacific Missile Range.

Most of the launchings will be made from two *Thor* pads at Vandenberg AFB. But the space agency also is preparing to construct three *Atlas-Agena* and one *Scout* pad at the Navy's neighboring Point Arguello, Calif.

The *Atlas-Agena* pads—scheduled to be completed by 1963—will be used for tests of the missile by NASA and stepped-up firings in the Air Force's *Samos* and *Midas* programs. The *Scout* pad will be completed by mid-1962 and will be used by NASA for its ionosphere satellite testing plans.

NASA will kick off its Vandenberg program with an international cooperation shot with Canada. Using a *Thor-Agena B booster,* it will attempt to place in a north-south orbit a Topside Sounder *S-27* satellite, which will measure electron density in the upper atmosphere at altitudes from 200 to 700 miles.

Other shots in the NASA program include:

A rigid version of the passive communications satellite *Echo* to be launched in the last half of 1962.

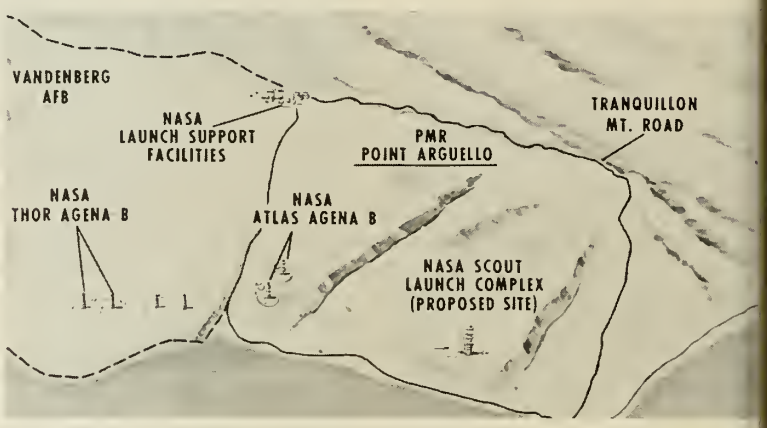
The Orbiting Solar Observation satellite *S-16,* which will attempt to measure the sun's ultraviolet rays.

All of the shots in the *Nimbus* program. This is an advanced meteorological satellite weighing 650 lbs. and including six television cameras in its payload.

POGO—the Polar Orbiting Geophysical Observatory which will be launched with a *Thor-Agena B* booster.

• **Less than was hoped for**—While the stepped-up activity and construction will be a real boon to West Coast missile operations and fulfills both the Air Force's and NASA's plans for PMR, it is apparent that it falls far short of the Navy's hopes for its Point Arguello facility.

The Navy began construction of Point Arguello in 1957 in the belief that it was this country's last opportunity to build a missile range from the ground up which could provide the necessary facilities for years to come.



MAP SHOWS proposed new NASA launching facilities at Vandenberg AFB and adjoining Navy Pt. Arguello installation. (Broken line indicates boundary of Vandenberg.)

It originally advanced plans which envisaged the spending of some $4 billion on PMR facilities in a 15-year period. Included in the proposed launch sites were five pads for the Air Force's *Samos* and *Midas* programs, and pads for *Thor*-type vehicles.

NASA's decision to use Vandenberg's *Thor* pads for its polar-orbit satellite program kills chances for construction of *Thor* pads at Point Arguello. In addition, the Air Force was given control of the Defense Department's space program, which has curtailed Navy space plans.

As a result, no pads have been built at Point Arguello for strictly Navy use. However, what has hurt the Navy even more has been the decision to give a joint Air Force-NASA committee control over who will use launch sites and whether new ones should be built at both the Vandenberg and Point Arguello facilities.

At the same time, NASA and DOD objection have squashed Navy plans to spark further increases in Point Arguello activity as a launch site for the Air Force's proposed big solid booster engine, the construction of an equatorial launch site on a down-range island, and a mobile launch site on a ship.

Navy officials thought that the deep canyons at Point Arguello would be ideally suited to confine the noise of huge space boosters.

Government experts now believ that their earlier estimates—which fore saw a noise hazard from solid booste breaking windows 25 to 30 miles awa —were overly pessimistic.

They now feel that the acoustic fac tor will be no worse than that of the bi liquid boosters which they intend t launch from the Atlantic Range facil ties at Cape Canaveral. They also poir out that AMR is more ideally suited fo deep space operations.

Officials of the Air Force, NASA and the Defense Department have a told congressional committees that ne ther the island equatorial launch sit nor the mobile ship-launching pad ar needed at the present time.

That position, they maintain, has nc been changed by President Kennedy order to go ahead with the manne lunar program. The only advantage c an equatorial launch site is that it avoid the present dog-leg operation require of equatorial shots from Cape Canav eral. It is far cheaper to use the Cap for such shots than it would be to buil a new launch facility on some Pacifi island, according to these officials.

The same sort of joint NASA-Ai Force-DOD thinking applies to th Navy's proposal for a mobile launc pad. At the present time they clair there are just no foreseeable space mis sions requiring such a facility.

Hurricane hunter . . .

Tiros III to Advance Weather Work

NASA's latest meteorological satellite will pack two wide-angle TV cameras to improve on quality of pictures taken by its predecessors; three radiation experiments aboard

NASA WILL TAKE a giant step forward in its weather observation system this week with the planned launch of a *Tiros III* meterological satellite designed to provide information on the origin, development and movement of hurricanes.

If the launch is completely successful, the 285-lb. satellite will circle the earth every 98 minutes in a 400-mile-high orbit and—like its sister satellites, *Tiros I* and *Tiros II*—transmit thousands of television pictures of the earth's cloud cover to ground stations for weather analysis.

Tiros I, the first satellite in the weather observation system, transmitted 22,950 pictures in its 78-day life. *Tiros II* has transmitted more than 33,500 pictures and still operating after seven months. *Tiros III* is of particular importance because its expected lifetime coincides with the current hurricane season.

In an effort to improve the quality of the pictures taken, *Tiros III* will be equipped with two wide-angle television cameras. The earlier satellites in the program had one wide-angle and one narrow-angle camera.

Tiros III's wide-angle cameras will each use a one-half-inch Vidicon tube. An electronic beam will convert the stored pictures into a TV-type electronic signal which can be transmitted to ground receivers.

Connected to each camera is a magnetic tape recorder which can store up to 32 pictures during each orbit for transmission earthward when the satellite is within the 1500-mile command range of a ground station.

• **Some changes made**—Other innovations in the hurricane hunter include improved remote control programers for the electronic equipment and new transistorized circuits in the electronic clocks which trigger the cameras.

Other instrumentation — including beacon transmitters, attitude sensors, horizon scanners, telemetry circuits and a magnetic orientation control system—is identical to that used in *Tiros II*. Also as in *Tiros II*, the satellite contains infrared radiation experiments to measure sun-earth radiation relationships.

Power for the operation of electronic equipment is furnished by chemical batteries charged by more than 9000 solar cells mounted on the tops and sides of the spacecraft.

Tiros III will carry three radiation experiments, one scanning and two non-scanning. The scanning experiment consists of five sensors to map radiation in various spectral fields and is essentially the same experiment which was conducted by *Tiros II*. This experiment includes mapping of reflected solar radiation, long-wave radiation emitted from the earth and its atmosphere, temperature of the earth's surface or cloud tops and temperature of an atmospheric level varying with the amount of water vapor at an average altitude of about 25,000 ft.

One non-scanning type is the same as in *Tiros II* and *Tiros III*. It will provide gross heat-budget information by measuring reflected solar radiation and long wave radiation emitted from the earth and atmosphere.

The second non-scanning experiment is new, and was designed by Dr. Vernon Suomi of the University of Wisconsin. This experiment also will measure the gross heat budget, but the data will be more continuous—since the sensors can view the earth almost all of the time.

Tiros III is a cylindrical satellite resembling a large hat box, 42 in. in diameter and 19 in. high. It will be launched from Cape Canaveral with a three-stage *Thor Delta* vehicle. Its orbit will be approximately 400 miles high, at an inclination of 48 degrees from the equator, at speeds approaching 17,000 miles per hour.

With the exception of the infrared experiments, the satellite was designed and constructed by the Astro-Electronics Division of RCA, Princeton, N.J. RCA was also responsible for the special ground station equipment. Barnes Engineering Company, Stamford, Conn., provided radiation detectors under contract to NASA.

Overall responsibility for the flight rests with NASA. The operational phase of the flight is under the direction of the Goddard Space Flight Center. ⌘

Douglas to Develop Rebound Orbiting

NASA has oworded a study contract to the Douglas Aircraft Corp. for developing orbital placement techniques and engineering design techniques for the Project Rebound spacecraft.

Douglas was one of nine companies submitting proposals to the Goddard Space Flight Center, which is directing the project. The contract amounts to approximately $450,000.

Rebound is a passive communications satellite program in which inflated balloon-type sotellites—larger and more rigid than the 100-ft. Echo I—are to be placed in orbit with one lounch vehide. NASA soys that a number of such sotellites, spread oround the world and acting os mirrors to reflect signals between ground transmitting ond receiving stations, could eventually provide continuous communications on a global scale.

Present plans for Project Rebound are to put six satellites in orbit, using two Atlas Agena B vehicles, during 1963. The orbital placement technique to be developed by Douglas will attempt injection of the satellites into one common circular orbit 1500 and 2000 miles above the earth with equal circumferential spacing between satellites.

Communications experiments will be conducted from ground stations in the U.S. and other nations. Britain and France ore constructing stations in Europe.

Laser Seen Replacing Radar In Space Navigation within Decade

GPL presents glowing report on laser studies at meeting of Institute of Navigation; Carbonara is winner of 1960 Thomas L. Thurlow Award

by Charles D. LaFond

WILLIAMSBURG, VA.—Lasers will be capable of outperforming radar for space navigation. Used in spacecraft within the next decade for distance and velocity measurements over cislunar range, such systems will be accurate to one part in 100,000.

For a system using pulsed emissions, only two-ft.-diameter transmitting and receiving mirrors would be required. Estimated average beam power would be roughly 66 watts, bandwidth might have a frequency spread of one part in 10^{13}, and a beam spread of about 0.2 second arc.

These conclusions were recently presented here in a paper co-authored by Dr. Cecil B. Ellis and Dr. Ivan A. Greenwood, both of GPL Division, General Precision, Inc., and delivered before the 17th Annual Meeting of the Institute of Navigation.

The paper summarized results of nearly two years' study by the authors of the potential and practical applications of laser (light amplification by stimulated emission of radiation) systems.

This year's meeting saw a marked increase in attendance with total registration exceeding 400, according to ION officials. The technical program covered all aspects of navigation—underwater, surface, air, and space.

Whether the increased emphasis on underwater and space navigation techniques or the attraction of reconstructed Colonial Williamsburg served to bolster attendance is debatable. Nevertheless, each session during the three-day meeting drew large and enthusiastic audiences.

The Thomas L. Thurlow Award for the outstanding contribution to the science of navigation during 1960 was won by Victor E. Carbonara, former president of Kollsman Instrument Corp. Carbonara was honored for his work in the design and development of the first automatic celestial navigator for aircraft (first units were used operationally in the B-52 and B-58 during 1960).

• **Laser research**—Dr. Ellis told M/R that GPL began its paper studies on lasers and optical pumping mediums almost immediately following first announcement of Hughes' ruby-laser effort.

Initially company-funded (well over $100,000 so far), GPL later studies were supported in part under a Rome Air Development Center, USAF, contract investigating the whole field of advanced communications technology.

There are four principal virtues in the use of lasers for space navigation, said Ellis:

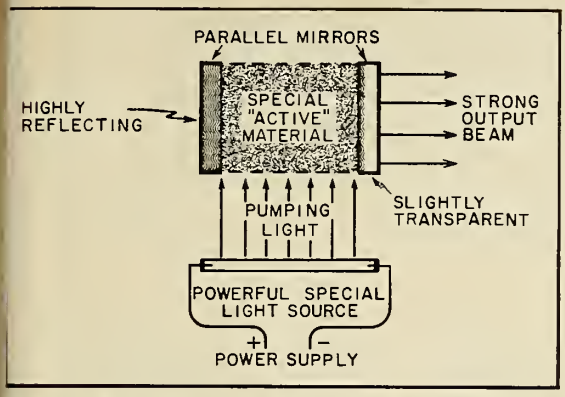
1. They are small in size and entirely self-contained.
2. They provide long operating range at low power.
3. Reception is essentially noiseless.
4. Measurement is extremely accurate.

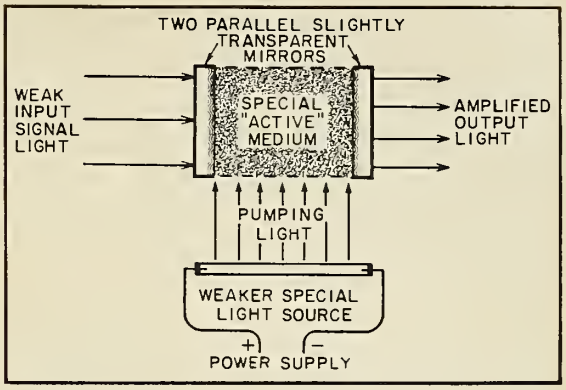
A laser transmitter, he said, will permit an extraordinary degree of parallelism and narrowness of frequency bandwidth in its output beam. The divergence angle of the beam eventually will approach 1 microradian, or about 0.2 second of arc.

Moreover, bandwidth in low-power beams now have a frequency spread of only a few parts in 10^{11}. In the next several years, Ellis believes that a spread of 1 part in 10^{12} or 10^{13} will be reached even at high-power levels.

• **Receiver next?**—A major piece of hardware— and still a missing link—is the development of a laser receiver. This, Ellis said, will be forthcoming shortly. (Note: It is reported that GPL will announce development of a working laboratory laser receiver within the next several months. GPL officials neither confirm nor deny the possibility, but it is known that the division numbers itself among the many who are driving hard in this area.)

Ellis indicated that such a receiver would be very similar in construction to that of the transmitter. In the laser configuration of the transmitter, two precisely parallel mirrors are employed separated by the pumping medium





SIMPLIFIED DIAGRAMS of transmitting (left) and receiving (right) laser systems.

(such as synthetic gem ruby). One is almost a perfect plane reflector; the other is slightly transparent for emitting the output beam.

In a receiver, he said, both mirrors would be slightly transparent.

A major problem, of course, is that the receiver must be matched to the transmitter. That is, the receiver mirror spacing must be in resonance for the wavelength of the transmitted signal.

Further, the axes (perpendicular to the mirrors) of both receiver and transmitter must be parallel within a very close tolerance to prevent the received light ray from "walking off" the mirror edges before amplification.

However, Ellis asserts that this inherent discrimination serves to reject extraneous background light and provides a nearly noiseless receiver. This holds true even in a receiver aligned with the sun.

Internal noise of a receiver, created by the omnidirectional glow of the laser active material during operation, is similarly negligible, Ellis said. Thermal noise is no problem at all—since the system would operate at temperatures below that necessary to emit energy in the visible portion of the spectrum.

• **Navigation measurements** — Distance measurements using laser techniques, Ellis feels, will be similar in approach to that by radar. Pulses will be transmitted and the reflection delay measured. Scanning will be accomplished also with techniques standard to radar.

The great difference, however, is in accuracy and the differences in antenna size. With its narrow beamwidth angle and lack of thermal noise, the laser system will permit operation out to distances now impossible with radar systems capable of being borne in a spacecraft.

Ellis suggested that a typical laser system of the future, using 2-ft. reflectors and having a 66-watt average beam power, would permit ship-to-ship distance measurement in space at 160,000 km to an accuracy of 1 part in 100,000.

Such systems, said Ellis, will have a probable efficiency of 10%. Even allowing for all the associated electronics needed for determining distance, power requirement during the measurement period would be about 800 watts.

Pulse rate over such a distance would be 1/sec.

• **Orientation problems**—Initial orientation for the hypothetical navigation system, said Ellis, would probably require use of a 2-ft.-dia. optical telescope. Once aligned roughly with the telescope, angular scanning of the laser beam about the target would permit precise alignment.

Ellis emphasized that the laser will be capable of out-performing radar only after it is aimed properly. It is not better than conventional microwave for search missions.

It would be a simple matter, Ellis pointed out, to employ the same 2-ft. mirror for transmitting, receiving, and for the sighting alignment.

Lasers will offer another great advantage, Ellis stated, in determining altitude measurements between vehicle and a relatively small area on a target planet. Using microwave techniques with a comparatively broad beam, the resulting measurement actually is an average of distances over a wide range of points on the surface illuminated.

• **Velocity determination**—The use of Doppler frequency shifts with a laser system could be performed with great accuracy, according to Ellis. It requires a "tunable" receiver but, with a laser pulse transmission between two objects having relative motion, the frequency change will be many times the bandwidth of the echo. This then would be a large and measurable effect.

Ellis feels that tuning capability required by the receiver would be for response to a frequency up to one part in 100,000 away from the transmitted signal frequency.

He suggested that tuning could be accomplished by employing a small gas-filled space between the end of the laser active medium and one mirror. By changing gas pressure (and thus the density), the velocity of light through the inert gas would change. This would change the conditions for resonance between mirrors.

This would permit scanning the expected frequency range until the return signal was received and subsequently amplified.

The advantage in this approach is the avoidance of shifting the mirrors. With the accuracy of parallelism required between reflectors, adjustment is impractical, he said.

• **Moon landing**—For velocity measurements near (1600 km) the moon or when approaching the moon for a landing, Ellis presented an analysis of a suitable laser system using a 2-ft. reflector.

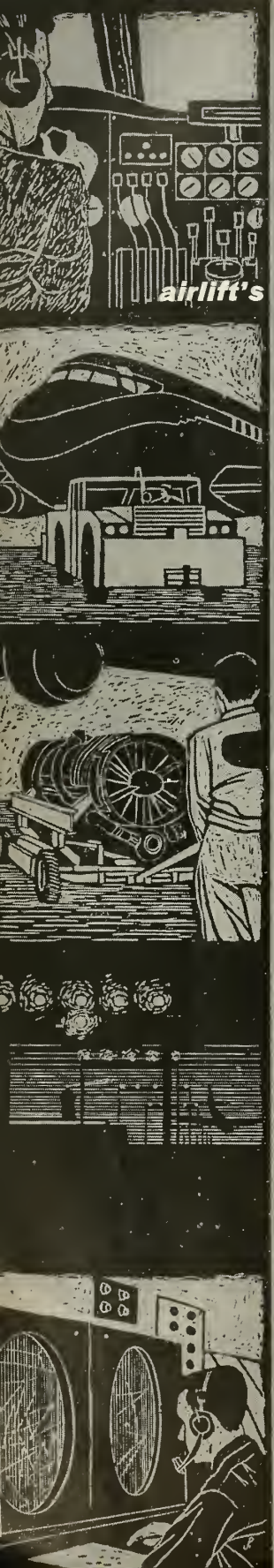
With the spacecraft moving at about 2300 knots parallel to the lunar surface, an average transmitted beam power of 40 milliwatts would provide magnitude and direction of velocity every 8 seconds, Ellis said. These figures would have an accuracy to 0.1%.

At 50,000 km and all other conditions the same, average transmitted beam power of about 40 watts would be required.

In time, Ellis believes that laser systems of this type will be built weighing about 10 lbs. and occupying about one cubic foot of space.

• **When?**—Conceding that today's laser transmitters are all laboratory research devices and receivers are publicly non-existent, Ellis feels practical prototype laser systems will be available in from 3-4 years. Today, some 16 different approaches being taken toward laser hardware development. Most of these will yield useful systems for communications, navigation, and even long-range detection and tracking.

Operating hardware will be ready by the time it is needed for future spacecraft in this decade, Ellis asserts. ⁂



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Technical Countdown

ELECTRONICS

Saturn Computer Selected

Librascope Division of General Precision, Inc., reportedly is the winner in its competition with IBM for the contract for guidance computers in the early *Saturn* booster program. The system will be a modified version of the *Centaur* digital computer developed by Librascope. Selection was made after nearly a year of test and evaluation by NASA's Marshall Space Flight Center in Huntsville. Award will be announced officially in about four weeks.

First Laser Receiver Developed?

Industry informants say GPL Division of General Precision may have produced the first laboratory-type laser receiver. In any event, look for the company to announce a big advance in laser technology within two months.

Army Pushes Radar Research

A mile-high mountain-top radar beacon is being used by U. of New Mexico scientists in an Army program to study effects of the atmosphere on radar beams. The precisely located beacon on top of Goat Mountain provides a signal to the main station, 45 miles away, to allow researchers to accurately measure the errors caused by varying atmospheric conditions.

Miniaturization Advances Revealed

A solid-state microwave transmitter, developed by General Telephone, is 1/7 the size of conventional transmitters. GT says the unit has 11 times the life expectancy and 10 times the frequency stability of predecessors. It was developed for the Air Force for possible space applications. Output power is two watts at S-band frequencies (1700-2300 mc). Not to be outdone, General Electric has demonstrated a miniature transmitter which uses a single tiny ceramic oscillator. Transmitter and power supply can be held in one hand. Range of the unit, with 30 mw at 7300 mc, is about 50 feet.

ASTRONAUTICS

Meteoroid Protection Being Studied

"Meteoroid bumpers" to protect space vehicles against damage by particle collisions are being studied by General Dynamics/Convair under a $54,000, 1-year NASA contract. Study will involve theoretical research in meteoroid impact in terms of mass and velocity and experiments in hypervelocity impact, using shaped explosive charges to achieve impact velocities up to 20,000 feet per second.

Astronomer Praises Electronics Industry

Radio astronomers are more than satisfied with the present state of the electronic art, according to one JPL scientist. Astronomers admit that the electronics they use are better than really needed—and that the chief roadblock is now the physical difficulty of extracting information from space.

Earth-Venus Meter Stick Studied

NASA is studying an in-house proposal to use the distance between the Earth and Venus as a means of discovering new planets or new moons of old ones in our solar system. Using the almost perfect radar reflectivity of Venus and the accurately determined distance between the two bodies, the perturbations of the two orbits would be studied and, from this data, the approximate size and location of previously unknown bodies could be determined.

ADVANCED MATERIALS

Water Bullets Puncture Steel

Drops of water traveling at 3400 mph penetrate thin pieces of metal like a rifle bullet and leave sizable dents in thick sections of copper and stainless steel. Westinghouse researchers also note a burst of light at impact, but the nature of this phenomenon is not known. Purpose of the experiments is to evaluate the effect of water droplets on rapidly moving surfaces such as turbine blades, aircraft and missiles.

Tungsten Insert Process Perfected

Aerojet engineers have perfected a hot-worked tungsten insert process that starts by flame-spraying the metal on a mandrel, continues through a 5000°F two-hour heat-treat and ends with a hot spinning operation which works the insert exactly to the desired contour.

High-Temp. Strain Gages Advanced

Bureau of Standards researchers have upped the resistivity of ceramic cements used to fasten strain gages to hot surfaces. A technique has been devised to increase the resistance to ground by applying a fired-on ceramic coating to the grid of a specially developed unbacked gage.

PROPULSION

Centaur Insulation Jettisonable

Engine insulation for *Centaur* consisting of 10-ft.-diameter and 12-ft.-long sections will be jettisoned just prior to ignition. The half-inch panels use a freon-polyurethane foam in a honeycomb core covered by fiberglass. A helium bath between the engine and the insulation reduces heat transfer.

ASW ENGINEERING

Navy Looks to Bigger Hydrofoils

The U.S. can use current technology to build a 300-ton hydrofoil with speeds up to 60 knots, says Ralph Lacey of the Navy's BuShips. He adds that a 500-ton craft with a 60-knot capability could be produced in 2 years with an accelerated program, and BuShips is looking ahead to hydrofoils of 1000 tons or more with speeds up to 100 knots. Lacey disclosed that Boeing's BCH-1, 110-ton, 50-knot experimental hydrofoil will be ready for sea trials next year.

Hydroskimmer Contract Due by Fall

The Bureau of Ships is reported planning to let a contract this fall for a 20-ton ground effect craft. It will employ a full peripheral air curtain for lift and two air screws for horizontal drive.

LIFE SUPPORT

Wasteless Food Considered

Soviet scientists maintain that it is possible to produce special foods which the human organism can consume completely without leaving a residue. Russian biologists are considering using hydroxides of lithium and calcium to absorb CO_2 during short-time manned space flights.

Zeus Resistors Made at Rate of On

Western Electric spent own funds to design and develop fully automated computer-directed line

by James Trainor

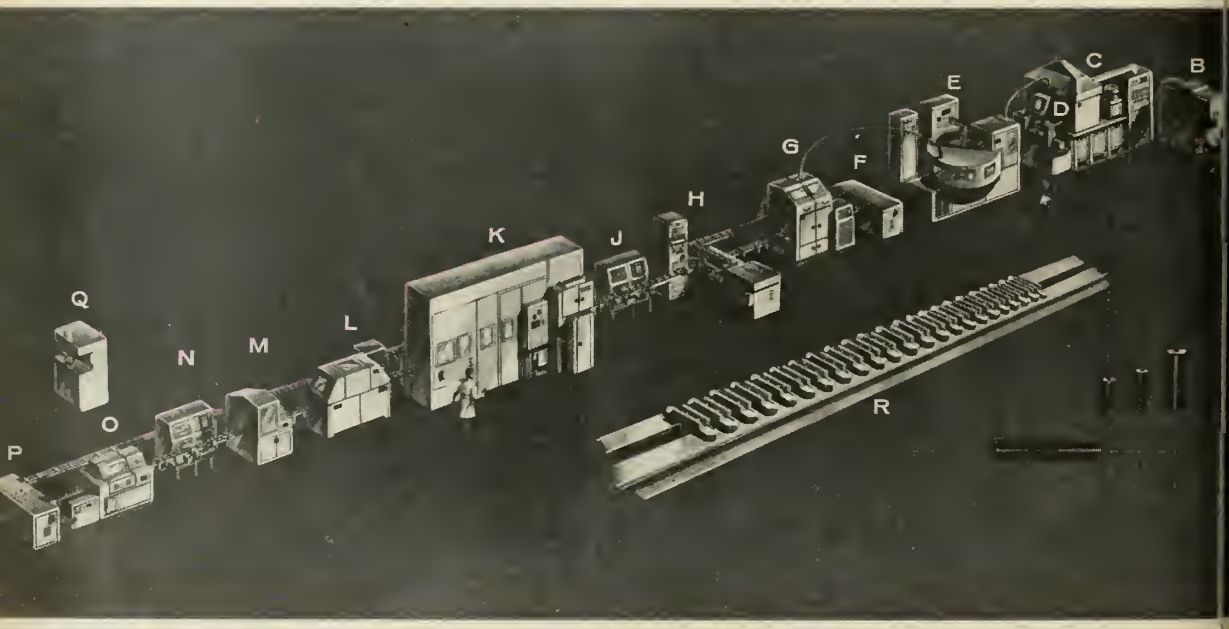
WINSTON-SALEM, N.C.—Carbon deposited resistors—untouched by human hands and made to order in just three seconds—are pouring from a unique computer-controlled production line.

The 110-foot-long facility, revealed for the first time last week, was developed by Western Electric Co.'s North Carolina Works to meet stringent military requirements for the *Nike-Zeus* anti-ICBM (M/R, Jan. 30).

In a single engagement, the *Zeus* system will call into play 2,000,000 of these elementary components. In addition, they must function under any and all environmental conditions with a rate of failure not exceeding one in 200,000,000 hours—a reliability 10 times that already achieved by conventional semi-automatic and manual production techniques.

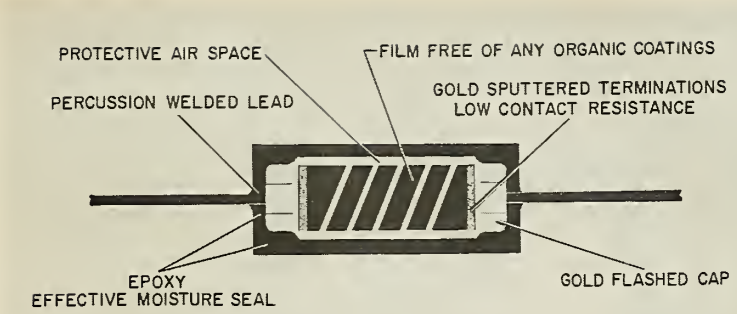
Before Western Electric could automate production to *Zeus* specifications, it had to find out why resistors had failed in the past. Detailed analysis isolated the three main culprits: inorganic material in contact with the resistor had an aging effect on the component; persons in manufacturing the resistor left their contaminating mark which acted to change the value of the resistance element; and, finally, given enough time, it is almost impossible to keep moisture from seeping into the resistor.

• **Two million per year**—Once the trouble spots were isolated, Western Electric engineers designed and built a fully-automated, computer-controlled production line in about six months. The whole job, paid for out of Western Electric's own pocket, cost $300,000 to design and develop and another $312,000



ARTIST'S CONCEPTION of Western Electric's fully automatic, computer-controlled production line for turning out a reliable, completely sealed deposited carbon resistor every three seconds. Shown are the 11 machine stations, the computer with its input and output circuits, a detail of the conveyor line (center) and examples of finished resistors (lower right).

ach 3 Sec.



CUTAWAY of carbon resistor shows active element and its protective covering.

or the machines and computer.

The line—the first completely automated process to manufacture any discrete electronic component—consists of eleven machine stations, the computer and its control cabinets, and a percussion cap-lead welder. It is capable of turning out approximately 2,000,000 resistors a year on a one shift basis.

At the heart of the system is the computer—a Librascope LGP-30, modified for "on line" use—with its input and output circuits which had to be extensively redesigned in order to control the programing, setup and feedback control of the individual machines.

To produce the four wattage sizes—¼, ½, 1 and 2—and the large number of resistance values required, the computer performs four basic functions:

—Programs production requirements for a month, completely scheduling and arranging the work according to the power sizes and resistor values to be produced.

—Analyzes control statistically from data plotted at three critical points in the automated process and determines if a trend is developing.

—Formulates information to detect any drift from manufacturing tolerances and, if such a drift develops, calculates new setup information for the appropriate station from previously stored data.

—Provides the initial setup of wattage size at eight machines and resistance value at six.

• **Production sequence**—The nucleus of the resistor is a tiny ceramic core produced by the American Lava Co. from processes developed by the Bell Telephone Labs. Fed automatically from a hopper at the beginning of the line, the core moves along a conveyor belt to the coating machine at a speed controlled to within an accuracy of 0.1%.

As the core moves through the coating machine, it is rotated to insure that the crystalling carbon is deposited uniformly. Inert nitrogen gas is continuously flushed through the machine to prevent oxygen contamination of the material. Decomposed methane gas at a temperature of 2100°F is used for the coating process. After the carbon is deposited on the core, the piece is cooled to room temperature and moved through the first inspection station.

The three parameters which govern the resistance coating value—the speed of the core through the machine, the pyrolysis temperature and the flow of methane gas—are all controlled by the computer through a feedback loop around the furnace.

A 100% inspection is given the core using the Kelvin bridge principle before it moves to the terminating machine which sputters a gold contact over each end.

• **Gold capped**—At a pick-up station the core is fitted with a mask, depending on its power size, to protect the center during the sputtering. It is then loaded onto one of the machine's 36 vacuum stations and covered with a bell jar which is pumped to a vacuum of 10 microns and then backfilled with argon gas at 90 microns.

A gold cathode sputters the ends of the core protruding from the mask with gold particles for approximately 50 seconds. The deposited layer of gold is made uniform by rotating the core on two rollers for maximum exposure.

Operating on a demand basis, the capping machine loads the resistor core onto a turret to hold it in position while the tiny gold-plated, hexagonal caps and leads are pressed over both ends. The capping force is sufficient to weld the gold plating of the cap to the gold on the ends of the core.

Also computer controlled, the capping machine uses two different capping assembly heads and three different sizes of caps for the four resistor wattage sizes.

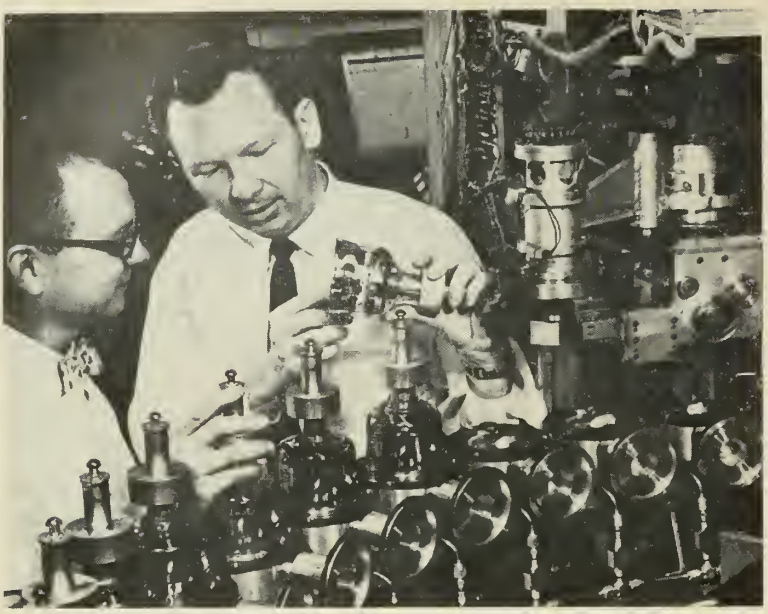
The helixing machine cuts a precise value for the resistor by rotating the properly chucked resistor against a diamond-impregnated wheel. The computer-controlled bridge monitors the cutting of the spiralled resistance groove and rejects any chipped or unevenly-coated resistor or any resistor that reaches value before 75% of its length is used or fails to reach value in its full available length.

To achieve the three-second spiralling speed—a fraction of that commonly used—a carefully balanced magnetic counter weight was used to hold the movable chuck assemblies against the diamond cutting wheel. A wheatstone bridge then inspects the resistor to insure that the proper value has been achieved and rejects the defective ones.

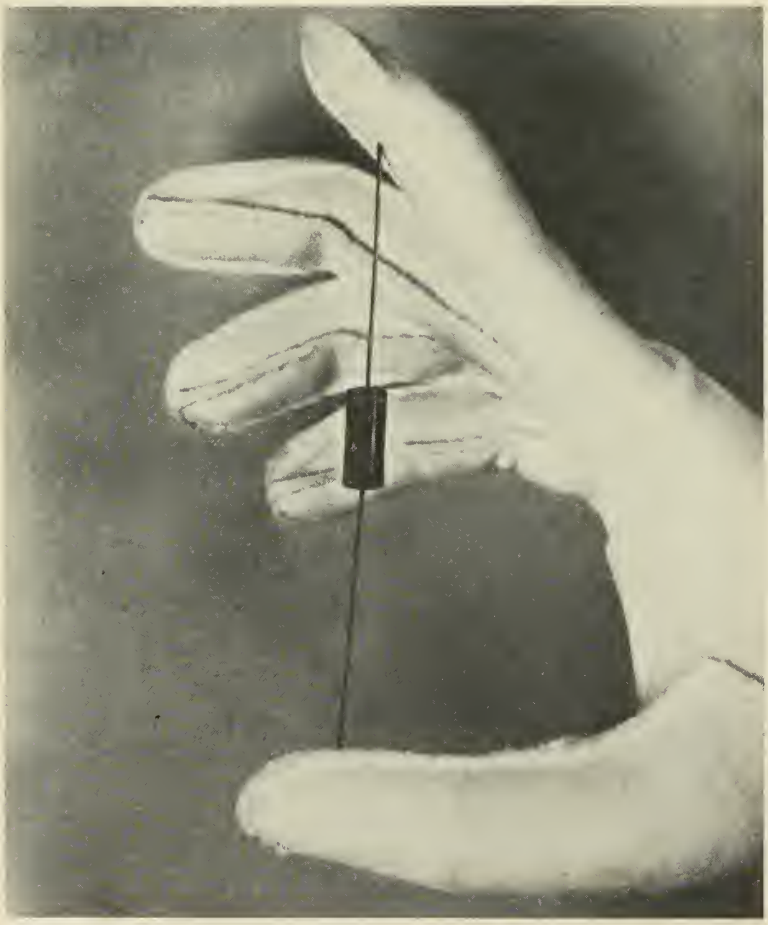
• **Leak detector**—The resistor is then fitted with a precured epoxy shell and two partially cured epoxy pellets and placed between two resilient rubber chucks before entering the encapsulating machine. (The resilient chucks prevent trapped air from causing leaks in the finished resistor.) Cured for 17 minutes in a 350°F oven, the partially cured pellets soften and form an effective seal with the precured shell. The curing process is terminated by passing the resistors through cooling water jets. A cartwheel detector checks each resistor to find any ballooning or cartwheeling of the resistor ends due to heating.

To detect any leaks in the protective coating the resistors are passed through a 165°F hot water bath containing a wetting agent to prevent surface bubbles from clinging to the resistor body. Ten photoelectric cells—capable of detecting leaks as small as 2×10^{-6} cc per second—watch for air bubbles indicating a leak. A special memory device then rejects defective resistors as they leave the bath.

The resistor's next stop is the marking machine which stamps the wattage, resistance value, production lot number and date on the encapsulated resistor. Using a modified offset printing technique, the machine has 1,700,000 marking values for resistance and 45 different code numbers. To be respon-



EVACUATED BELL JARS are used to sputter gold particles on ends of resistor core with gold cathode. Gold is later reclaimed from sides of jars for future use.



THE FINISHED PRODUCT—A resistor able to withstand the pressures of time and environment for 23,000 years. Acceptable yield is currently approximately 65%.

sive to computer control a bulky type head was used with the blanket ro and inking rolls mounted on a planetar gear arrangement.

• **Yield is 65%**—The final inspec tion station checks the resistance valu to ±1% and provides feedback contr to the helixing machine to compensat for shifts in resistance value caused b the heat of encapsulation.

The acceptable resistors are the packed into lots of 10 and 15 by th packing machine and inserted into sty rofoam blocks—the final process in th fully automatic operation.

An automatic machine outside th line percussion-welds the copper-coate leads to the gold flashed brass cap a rate of 3600 parts per hour. The wel is made by an extremely short (20 microseconds) arc of high intensity.

Another line—capable of producin ⅛ watt resistors at twice the rate of th first one—has also been built but is n yet in operation.

Although the design goal of th automated line is an acceptable resist yield of 85%, this has not as yet, bee reached. The current yield is approx mately 65%. Western Electric eng neers, however, feel that the design go will be reached and, perhaps, surpasse by improving the quality of ceram cores used on the line.

In the event that the *Nike-Zeus* approved for production, Western Ele tric officials estimate that ten such lin would be needed. However, if *Zeus* not authorized, the resistors from th line and those still being hand-made wi be used for the needs of the Bell syste and should prove adequate for that tas

With the advent of the fully aut matic, computer-controlled resistor lin the company officials said, the way h been paved for many more electron components to be automatically man factured including transistors, capacito and inductors.

British BMEWS Crews Training in New Jersey

MOORESTOWN, N.J.—British eng neers are learning how to operate th Ballistic Missile Early Warning Syste (BMEWS) in preparation for the da when the third and last BMEWS statio goes "on the air" at Fylingdales Mo in Yorkshire, England, in late 1962 early 1963.

Employes of RCA (Great Britai Ltd., are studying under British dire tion to become instructors for the se eral hundred engineers and technicia who will be needed to operate th Fylingdales installation.

RCAGB is an associate company Radio Corp. of America, prime contra tor for BMEWS through its major D fense Systems Division here.

Potential of Spark Plugs Ignored

New developments push spark rates above 1200 per sec.— increased use is anticipated in liquids; limited future in solids

by W. Johnston
AC Spark Plug Division, General Motors Corp.

THE RAPID EVOLUTION in propulsion technology has brought about a multitude of ignition systems and devices which all but ignore the most familiar igniters in the U.S.—spark plugs.

Spark ignition systems are usually considered and then eliminated for some reason which may not be completely valid. As with any missile component. there has to be a trade-off among the advantages and limitations.

For instance, pyrotechnic systems, using electrically initiated solid-propellant charges, are small and simple but entirely unsuited to many applications because of their single-start ability. They may ignite prematurely during storage.

Hypergolic ignition, reliable in most cases, is not completely satisfactory because some hypergolic materials are not self-igniting under all conditions, and in some cases specific impulse may be limited by restriction to certain fuels and oxiders. The start-up and shut-down procedures are very critical and can result in severe detonation if the propellant flow rates are not correct—and there are storage problems.

Catalytic ignition systems are not complex, but they result in large heavy engines, in many cases require regenerators or preheaters, and are contaminated or burned up during the combustion process. The system is also relatively expensive.

Hot-spot or hot-wall systems using glow wires or heat sinks are also quite simple. But they require large amounts of power, have slow responses and can be fouled by combustion deposits.

• **Conventional plug out**—The mechanism of ignition by sparks is probably the least known of all the systems. The common high-tension spark plug, used in automobiles and other reciprocating engines, has several serious limitations.

In this type of plug the demand voltage of the gap depends upon the material in the gap and its density. At pressures above atmospheric the demand voltage increases as pressure increases. At pressures below atmospheric the demand voltage decreases as pressure decreases, until a certain pressure is reached at which the demand voltages increase rapidly; at high vacuums extremely high voltages are required.

The variation of demand voltage of the gap and the high voltages used, in the range of 15 to 25 KV, requires extremely good insulation in the cable, igniter, and exciter. The presence of moisture adds to the insulation requirements.

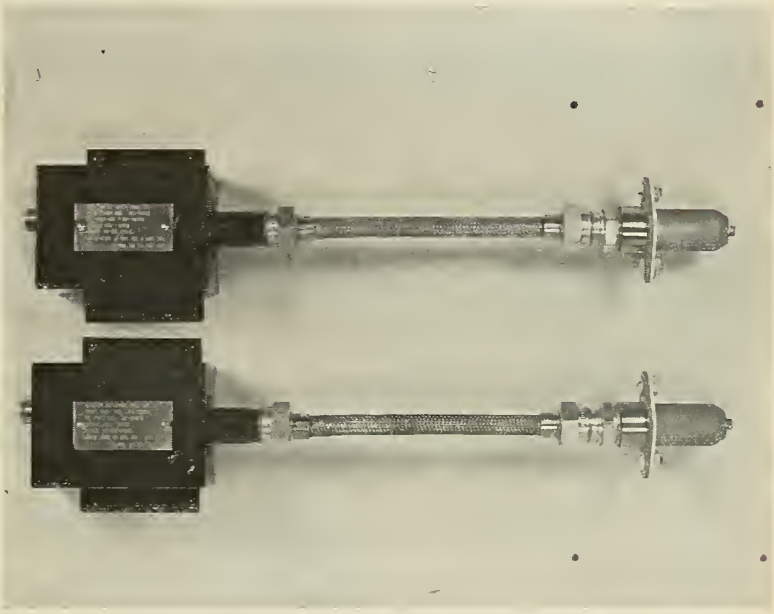
The vacuum of outer space necessitates very high voltages. If high spark energies are required, the exciter becomes quite complex and inefficient. In addition, the high-tension igniter is subject to fouling by the combustion deposits.

A spark ignition system not subject to these limitations is the creepage gap system—also known as surface gap, shunted surface gap, or low-tension system. This type differs from the high tension igniter in that a semiconductor is used in place of an air gap.

In a creepage igniter, the spark travels from electrode to electrode across the surface of the semiconductor. The exact mechanism of this spark is not known, but the gap requires a relatively low voltage to break down, usually between 1000 and 3000 volts.

• **Constant demand voltage**—The low voltage requirement of the creepage unit reduces the insulation requirement of the system, helping to eliminate the altitude flashover problem. The creepage gap also is substantially unaffected by the pressure at the gap or the material in the gap region. The demand voltage is about the same at 500 or 1000 psi, or at high vacuums, as it is at atmospheric conditions. In addition, the igniter is difficult to quench with

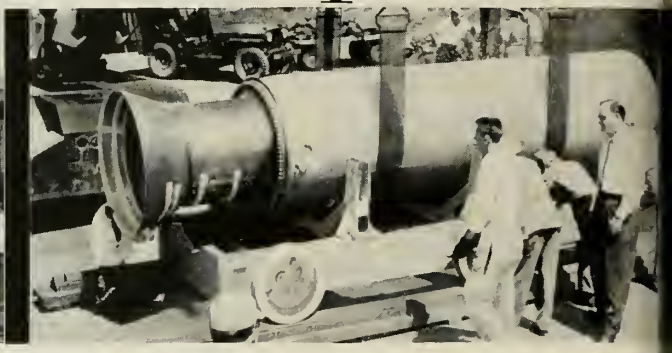
(Continued on page 41)



TWO TYPICAL ROCKET IGNITION systems manufactured by AC Spark Plug Division include exciters, igniters and interconnecting cables.

RELIABILITY in depth, from





REDSTONE *Working as part of Army's Ordnance team, Thiokol's Redstone Division conducts research into propellant formulation and solid propellant motor development. Experiences—gained in the labs, through developing prototype engines, and at firing bays contin since 1949—have resulted in many significant breakthro . . . providing a steady increase in size, thrust and perf ance of solid rocket motors.*

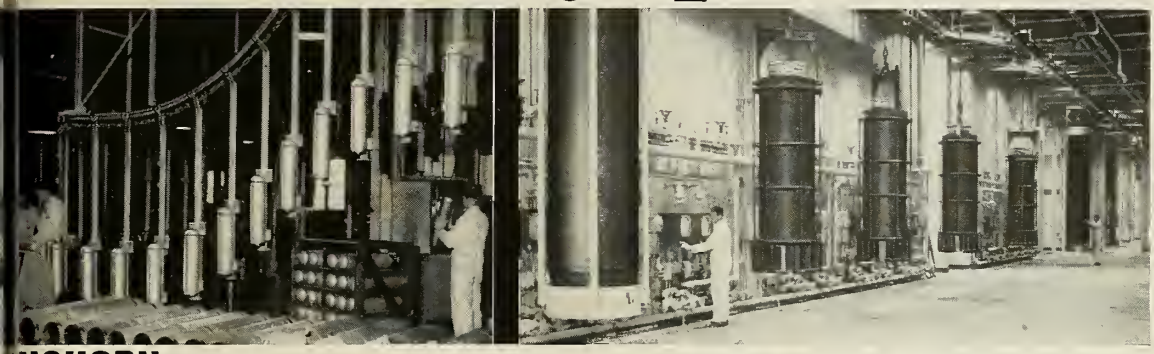


ARMY'S MISSILE ARTILLERY

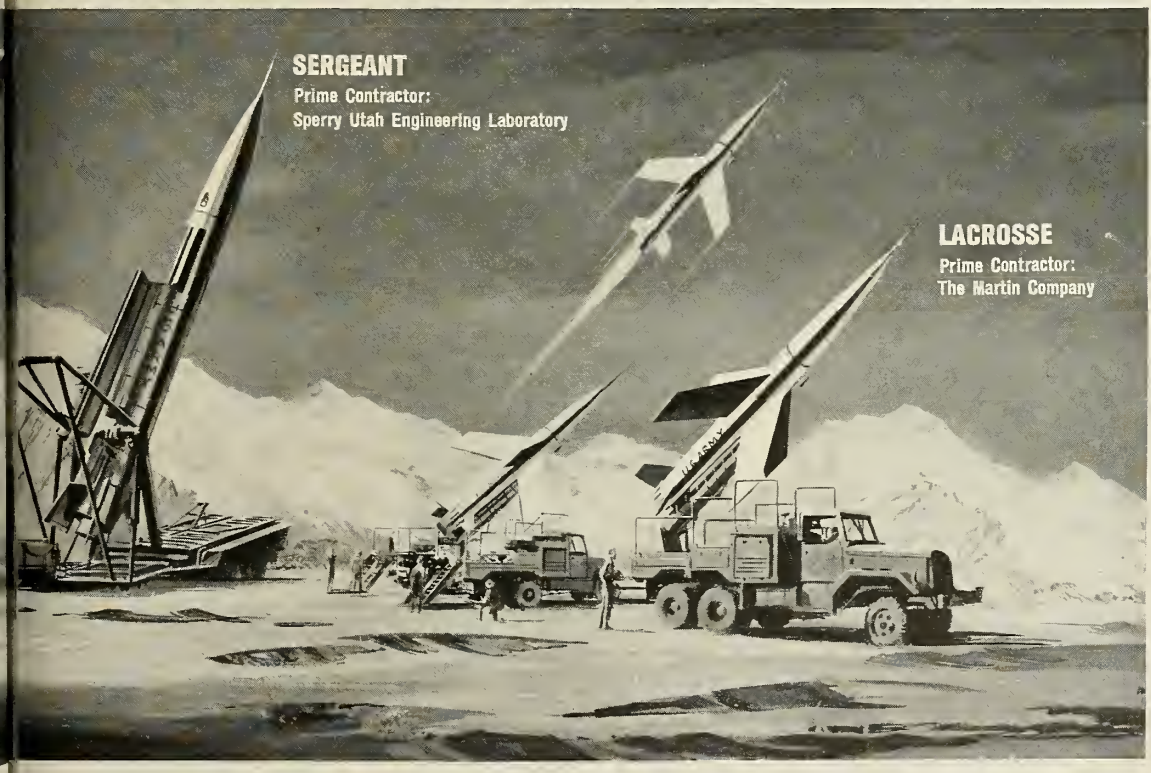
ARMY

In close cooperation with the Army and prime c tractors . . . Thiokol designs, develops and produ propulsion systems in wide variety to meet the n stringent military requirements. The associations distinguished by a series of major breakthrough propulsion engineering—beginning with small ro motors for tactical field use and carrying throug massive powerplants for anti-missile and satellite plication. All have checked out in static firings

esearch through production



NGHORN *Motors for the Lacrosse and for the developmental Sergeant and Pershing les, and for other major systems—all boasting remark- high reliability scores—move into smooth mass production at Longhorn. Incorporating most advanced methods of manufacture and quality control, Longhorn's total productive capability has yet to be challenged. Other Thiokol Divisions provide additional scientific and production capabilities.*



t tests with virtually 100% reliability. All have contributed mightily to advancing the total e of the art. Additional capabilities for Army's advanced thinking are provided by other okol Divisions. Utah, for large engine production—RMD, for sophisticated liquid systems nd Elkton, for diversified special motors.

ough fluid programming of assignments, and tegic enlargement of facilities for research, devel- nent and production, Thiokol maintains a live ability to meet any current and future propulsion llenge — military or space.

THIOKOL

THIOKOL CHEMICAL CORPORATION, Bristol, Pennsylvania
Rocket Operations Center: Ogden, Utah

Circle No. 4 on Subscriber Service Card

The World's Biggest 'Instant Ocean'

by William Beller

"INSTANT OCEAN" is the latest in a series of major new hydrodynamic facilities developed in the wake of the nuclear submarine.

The U.S. Navy late last month dedicated what it calls "the largest simulated ocean in the world" at the David Taylor Model Basin in the Maryland suburbs of Washington, D.C.

The facility is designed to test exotic naval craft such as hydrofoils, hydroskimmers and ground-effect machines—as well as more conventional vessels. A similar "ocean" is already operating at the Netherlands Model Basin, and another is being completed at the Admiralty Experiment Works in England.

Interest in advanced test facilities has pyramided with the advent of a host of new problems presented by the speed, quietness and range of the nuclear submarine and the potential high speed of surface-skimming craft.

• **Industry promised time**—The U.S. Navy's facility is housed in a new building covering five acres and sharing its quarters with a "rotating arm" basin 260 ft. in diameter.

Shakedown tests of both the ocean and rotating arm basins are now going on. By late summer or early fall, the facilities are expected to be ready to do useful work. Although they will put an end to occasional open-lake hydrodynamic testing they will have the advantage of practicality in helping to devise new water-going military vehicles.

Although Congress has said that the Model Basin facilities should be available to the maritime industry, government work has left little time for projects of private shipbuilders and naval architects. Now that the new facilities are almost ready to carry some of the research load, Navy officials are promising to give much more time to solving problems for industry.

• **Just like the sea**—The Maneuvering and Seakeeping Basin is the more dramatic of the two new facilities.

Pneumatic wavemakers located on two adjacent concrete banks of the rectangular basin are able to generate a variety of waves: regular and irregular long-crested ones, short-crested ones, and combinations. The entire range of ocean seas can be simulated up to those corresponding to gale-force winds. Data can be obtained relating to the maneuverability and control of surface ships, submarines and other vehicles operating in smooth and rough waters.

The waves' energy is absorbed by concrete lattices located on the banks opposite the pneumatic wavemakers. In this way, wave reflections are held down almost to zero.

The greater part of the 240-ft. by 360-ft. basin is 20 ft. deep; however, a 50-ft.-wide "deep-sea" section running almost the basin's length is 35 ft. deep, and useful for testing relatively large submarine models.

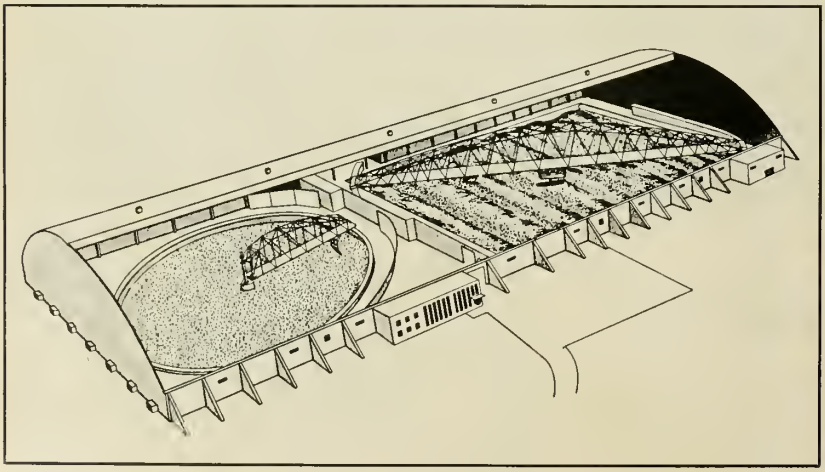
An ingenious arrangement of supporting structure and shuttling carriage permits test models to be towed in head or following seas at any angle from zero to 90 degrees and with simulated speeds far higher than those of existing craft.

This is done by spanning the basin's length with a steel-trussed bridge—mounted on tracks—which can not only traverse half the basin's width but can be rotated up to 45 degrees from the basin's longitudinal axis.

An aluminum-tubed carriage for towing models is suspended from tracks attached to the bridge's underside. Maximum carriage speed is 15 knots. Trolley wires running the bridges' length carry the power for ship model motors, carriage drive, instrumentation and control.

In this way, through appropriate rotations and translations of the carriage and through selected energies supplied to the wave-making units, an infinite variety of sea conditions can be imposed on test models—all the way up to simulated waves 100 ft. high and 2500 ft. long, breaking in any direction and with a large range of relative speeds.

• **Round and round it goes**—The second of the two new facilities—the Rotating Arm Basin (RAB)—is needed to give "rotary" coefficients, so important for determining the stability and control characteristics of maneuvering or turning vessels. These coefficients are usually approximated or extrapolated from other data when the speeds of surface and underwater craft are rela





LEFT: *Cutaway view of Rotating Arm Basin (left) and Maneuvering and Seakeeping Basin (right).* **RIGHT:** *Albacore model show*

ively low. But, when design speeds vater-borne craft go into the 35-knot ınd above regime, more accurate ways o get the rotary coefficients must be ısed.

The Navy says that RAB will be ısed to find out the directional stability, naneuverability and control of high-peed submarines, torpedoes and surface hips. RAB is also seen providing de-ign data for high-speed hydrofoil craft ınd ground-effect machines.

RAB, in essence, is a arm pivoting ıround a small island located in the enter of a 260-foot diameter, water-illed basın.

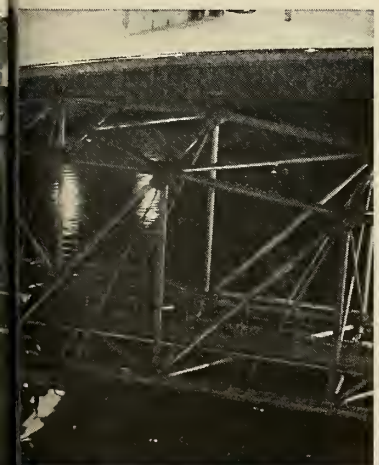
The arm, an aluminum truss, rides ıt its outer periphery on two wheels lriven by a pair of electric motors. It adially spans the basın and supports est models by a system of tracks, model ow carriage, positioning apparatus, owing struts and force balance.

Models submerged in the 21-ft.-deep asin are positioned in yaw, roll and itch from a remote control station.

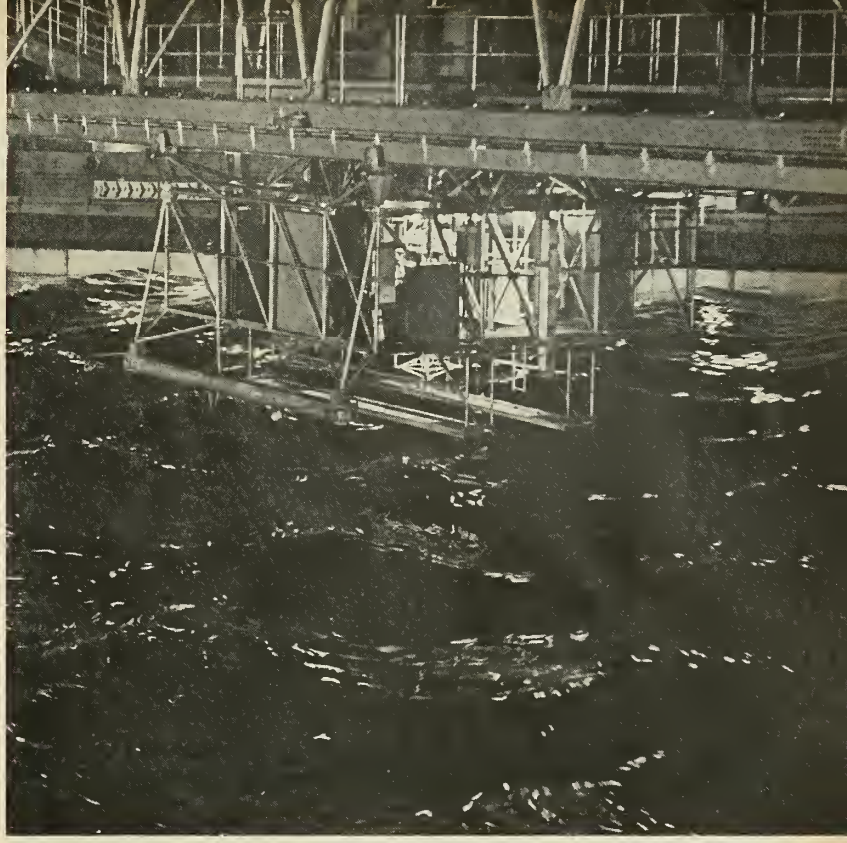
A steady-state arm speed of 30 knots ıt the 120-ft. test radius is attained in ess than one-half revolution of the arm; ınd 50 knots at the same radius it at-ained in two revolutions.

The Rotating Arm Basin and the Maneuvering and Seakeeping Basin will ;ive the Navy highly reliable test data or the design of high-speed ships. Such lata has been hard to get because, in he past, model tests could be run only n smooth water or in water with waves hat a real ocean would disown.

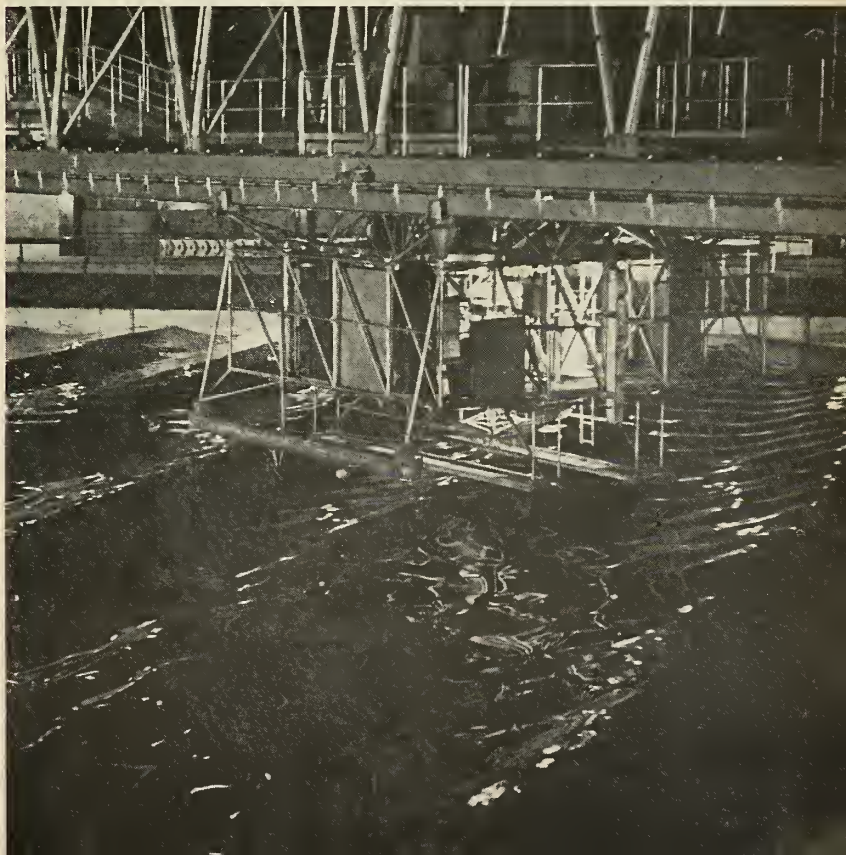
Now that realistic waves will soon e generated in the new facilities, and ıigher model speeds introduced. the Navy can design craft better able to ake severe evasive action, to serve as stable platform for launching guided nissiles or aircraft, and to go at rela-ıvely high speeds just above the water's urface, through it, or below it. ⌘



uspended from the RAB's pivot arm.



STEEL-TRUSSED BRIDGE, mounted on tracks, supports carriage for towing models through seas simulated in Maneuvering and Seakeeping Basin. Pneumatic wavemakers here create choppy waves (above) or regular rolls (below). Wave reflection is minimal.



Incremag Counting System Opens Nev

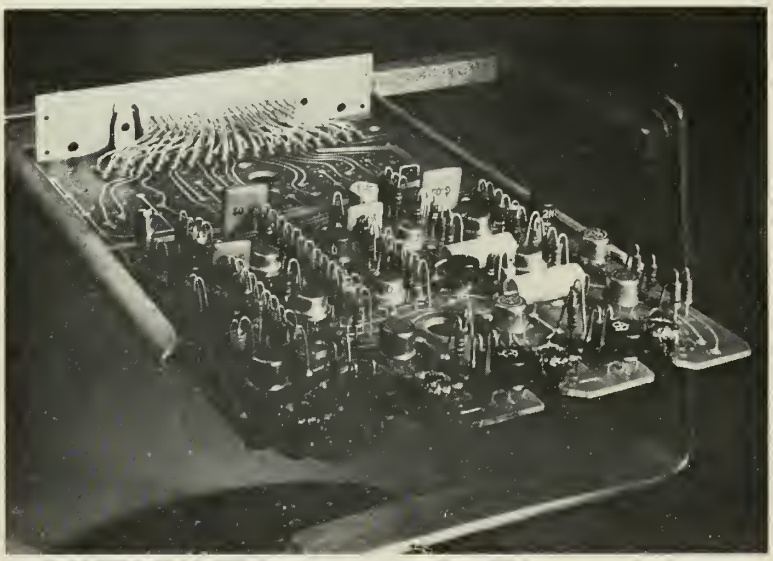
Firm forms new division to handle sales expected from concept based on toroidal, wire-bound magnetic coil

by John Judge

STAMFORD, CONN.—A magnetic counting system, currently circling the earth in the highly successful *Tiros II* weather satellite, is opening a wide new field for its creator, General Time Corp.

The system's nucleus is a transistorized magnetic counting-dividing circuit that delivers an output pulse after having received a predetermined number of periodic or random input pulses. It then acts as a counter, a frequency divider or an integrator.

Trademarked "Incremag," the development is compatible with existing digital or analog systems after certain conversions or matching circuitry changes.



WIRE-BOUND MAGNETIC CORES in foreground constitute the Incremag portion of a partially completed satellite programer.

• **Flux bucket**—The basic Incremag counting stage consists of a small toroidal magnetic core having a square B-H loop. This core is wound with a number of turns of fine wire. Two transistors and four resistors complete the circuit.

The core holds a fixed quantity of flux. This quantity is reached through an integral number of "counts." When the required number of constant magnitude pulses have been applied, the core will be driven to positive saturation.

The fall of the last input pulse triggers a second transistor in the circuit, which then drives the core out of positive saturation and back to negative saturation. When this stage is reached, the circuit is returned to its initial state.

The output from this counting stage may be used to fill another counter. As many Incremag stages as desired may be cascaded to provide a train of any desired count. An internal circuit is used to provide the required constant volt-second pulse to the first counter, regardless of the characteristics of the input pulses.

Incremag can be used to perform many of the functions formerly executed by binary components—with greater simplicity and reliability.

The potential of Incremag is so great that General Time has formed a new division to market the concept.

Other items pouring out the firm's research laboratories include a true rotary solenoid, and an Incremag satellite programer.

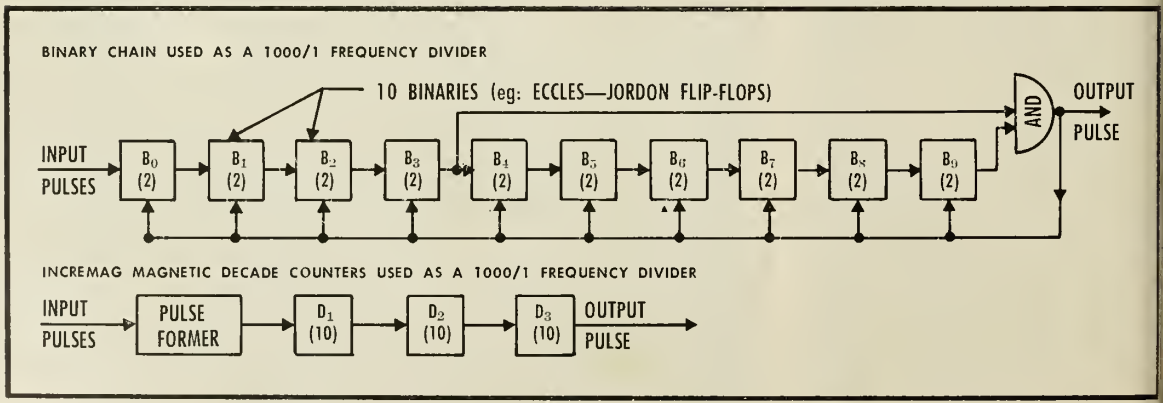


DIAGRAM SHOWS how Incremag can perform frequency dividing job, formerly done by binary chain, with greater simplicity.

Market Areas for GT

• **Generic marketing**—Incremag illustrates the General Time approach to the space business—and to the firm's growing industrial market. For years, General Time has been intimately associated with clocks and watches. Baby Ben, Westclox and Seth Thomas are part of the nation's vocabulary.

The firm no longer regards itself as a clock manufacturer. Instead, long-range plans are predicated on the concept "Time" and any path indicated by planners and researchers will be followed as long as it is related, however remotely, to this generic view. There is a discernible movement from mechanical capabilities into electronics, but without sacrificing the manufacturing and engineering background developed during the long history of the firm and its parent companies.

The basic thought is that in-house developments will lead GT into new areas. The company has no intention of diversifying by acquisition. This does not rule out purchases if such are deemed necessary or if the move is highly complementary to management's concept of the market.

A systems approach is being developed in certain areas. GT's Stromberg Division is producing and marketing a data collection and transmission complex called the Transacter. One current idea is to combine the transacter system with the Incremag and come up with a system for programing and automation.

The underlying theme is to develop marketable components while moving toward a systems capability. With this in mind, GT is eyeing the industrial area in automation control, programing and data processing. But the outlook covers a projected 10-to-15-year period.

The research activity at General Time is more applied than basic. Two laboratories, one in Stamford and the other in a Chicago suburb, work in harmony with the five U.S. manufacturing divisions.

Besides the *Tiros* series, GT is involved in projects with several prime contractors to the Air Force, Army, Navy and National Aeronautics and Space Administration. Most of the work is either classified or proprietary. The firm is pursuing studies in solid-state and other "no moving parts" areas related to missile/space and "time." ⁂

NBS' Rephrasing Searcher

AN ELECTRO-MECHANICAL information searching device incorporating the element of feedback has been developed by the National Bureau of Standards.

The system permits the searcher to rephrase or change his questions in the light of the previous answer. This feedback element is difficult to build into large, complex and centralized information systems.

The NBS system uses a "peek-a-boo" punched card technique based on its "microcite" concept. Each punched card represents an index word, and the hole positions identify documents pertaining to the index word. In ordinary use, the hole position is interpreted as a document serial number by means of a coordinate grid printed on the card or on a transparent overlay.

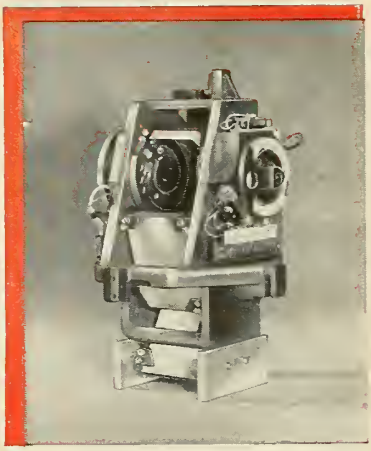
The new microcite is designed for sets of 18,000-document cards with corresponding abstracts carried in a 15-in.^{2} photographic film matrix. In operation this film matrix, appropriate to the card-set being searched, is selected and placed on a drum. The operator places the cards on an illuminated area of the machine and manipulates two control wheels to position a set of cursors on each unobscured hole.

Turning the control wheels causes rotation and translation of the drum so that as the cursor is set on each hole, a full-sized focused image of the citation and abstract corresponding to that hole is projected on a screen in front of the searcher. As he proceeds, the operator can obtain a copy of the abstract by thumbing a recording lever. Alternately, he may note the serial numbers on punched or printed paper tape.

The electrically coded serial-number output available for this transcription could also be fed into a document storage machine which would provide copies of complete documents in response to serial-number input.

The tool in operation at the NBS is designed for 18,000, but it could search millions of documents. The machine was developed under the sponsorship of the Department of Defense. ⁂

PRECISE STAR TRACKER



A celestial navigation system called for a tracking device capable of establishing a line of position within an accuracy of 300 feet. Kollmorgen came up with a constant deviation elevation system that positions a movable mirror, in relation to the fixed elements, to a repeatable accuracy of better than 5 parts in a million.

This compact package represents a combination of highly precise optical and electronic units in a housing only 6 x 6 x 10 inches. Kollmorgen's project from concept to installation, it is a typical demonstration of the company's scientific, engineering and manufacturing skills in optics, electronics, mechanics. Example: the precision optics (a prism and two mirrors) are of Kollmorgen manufacture. So, too, are the Inland torque motor*, the gearing and other precision-machined parts.

Our motive in this message: Kollmorgen offers proven capabilities in optics, electronics and precision machining of metal components . . . capabilities which could solve your problems in missile tracking, fire controls, navigation, or . . .?

Present us with a problem.

*Product of Inland Motor Corporation of Virginia, a Kollmorgen subsidiary.

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Satellite Might be Used to Verify

Stanford's Prof. Schiff is proposing that a gyroscope be orbited to look for the axis precession which must exist under Einstein's laws

by Robert L. Forward

A SATELLITE experiment now being proposed could uniquely verify Einstein's Theory of Gravity. It is scientifically simple, but it poses difficult engineering problems.

The basis of the experiment, suggested by Stanford University Professor L. I. Schiff, is this: Under Newton's laws, a spin-stabilized torque-free gyroscope in orbit around the earth has its spin axis pointed constantly in the same direction. But, according to Einstein's laws, the axis precesses approximately one microdegree per day. Schiff proposes looking for this precession, the expected value of which can be calculated only by using Einstein's Theory of Gravity.

There have been only three "crucial" experimental tests of the differences between the Einstein Theory of Gravity and the Newton Theory of Gravity. These three experiments are: the bending of light rays as they pass near the sun due to the gravitational pull of the sun on the photons, the decrease in frequency (energy) of the photons as they climb up out of the gravitational field of the earth, and the calculation of the correct shape for the orbit of Mercury.

In each of these cases, it can be shown that Newton's theory gives the incorrect result and Einstein's theory agrees with the experimental results. Thus it is known that Einstein's theory gives a better description of gravity than Newton's theory.

• **Patchwork theories**—However, as Schiff and others have pointed out, Einstein's General Theory of Relativity is only one of the many possible theories which go beyond Newton's theory that all masses attract each other *instantaneously* with the force law

$$F = -\frac{G M m}{r^2}$$

All the experimental results can be explained by using these other theories of gravity, so that the "crucial tests" do not distinguish between Einstein's theory and these other possible non-Newtonian theories of gravitation. For instance, the two experiments concerning the effect of gravitation on light rays can be calculated by using Newton's law and the experimental fact of special relativity that light has energy and therefore mass ($E = mc^2 = hf$).

Even the non-Newtonian perturbations of the orbit of Mercury can be explained away if one modifies the Newtonian idea of gravity by saying that gravitational effects travel at the speed of light, not instantaneously as Newton assumed in the formulation of his theory.

The reason, of course, that Einstein's theory is preferred over these other ad hoc, patchwork theories, is that Einstein's theory of gravitation not only includes the ideas of special relativity and the finite propagation of gravitation, but has connected them in a rigorous mathematical formalism which is free from possible internal contradictions.

What Schiff wants to do is find an experimental test of a gravitational nature that will be predicted correctly only by Einstein's theory. He has proposed that a spinning torque-free gyroscope be put into orbit and the direction of its axis determined over a period of time as it rotates about the earth. The spinning satellite will have to be a nearly perfect, homogeneous sphere.

According to the Newtonian concepts of gravitation and inertia, if we put a torque-free gyroscope in orbit around the earth, line it up on one of the fixed stars and then start it rotating, it will become spin-stabilized and will remain pointed at that position in space for all time.

Schiff has calculated this same example of a spinning torque-free gyroscope using Einstein's theory of gravitation. He finds that for an orbit in the earth's equatorial plane, the spin axis of the satellite will precess due to two gravitational effects that are contained only in Einstein's theory. One of these effects is due purely to the presence of the mass of the earth near the satellite:

**Robert L. Forward, "General Relativity for the Exp." Proceedings of the IRE, Vol. 49, May, 1961. Some of the material and figures from this paper were used with the permission of the IRE.*

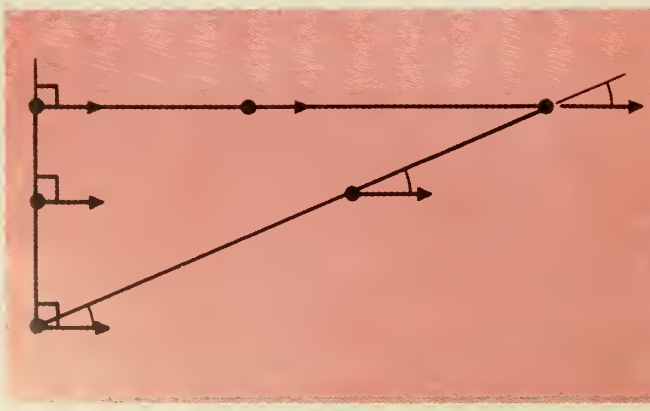


Figure 1

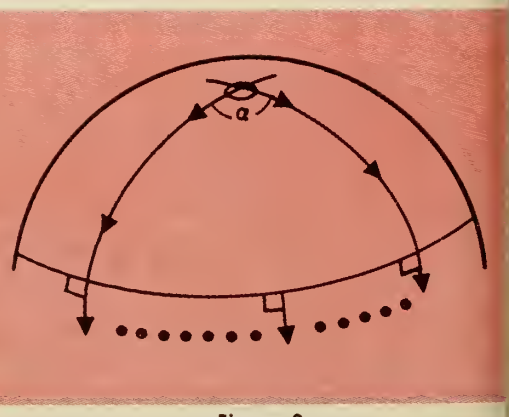


Figure 2

instein's Theory of Gravity

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Other Information

Since one of these circles has less than 360° in it, if we send a vector around this circle, the vector will not return to the starting position pointing in its original direction.

It is difficult to show this concept with a circle, but we can easily show it using spherical triangles. Suppose we are on a flat surface and we place a test vector at one corner of a triangle. Then, very carefully keeping the angle between the vector and the appropriate side of the triangle constant, we traverse the perimeter of the triangle and return to the starting point (see Fig. 1).

The test vector obviously returns to the starting point with the initial orientation. Now try this same simple experiment with a vector moving about on a spherical triangle (shown in Fig. 2). It will be obvious even to a flatlander in the two bodies. It was shown in a recent article in the *Proceedings of the IRE** that Einstein's theory of gravitation is directly analogous in many ways with electricity and magnetism.

For instance, the usual Newtonian gravitational field of a mass is analogous to the electric field of a charge. It was also shown that there exists a gravitational equivalent to the magnetic field which arises from moving or rotating masses. Thus, just as a rotating charged body will generate a dipole magnetic field, a rotating massive body will generate a dipole field which is the gravitational equivalent of the magnetic dipole field. And just as two magnetic dipoles interact and cause troques on each other, two rotating masses such as the spinning earth and a spinning satellite will cause gravitation-like torques on no torques, these would have to be eliminated by a protective shield.

What is needed is an apparatus designed along the lines of the Orbiting Astronomical Observatory. It would contain the necessary telescopes to determine a reference frame with respect to the stars, the readout devices to determine the orientation of the spinning sphere, a large chamber in which the sphere would float protected from meteorites and atmospheric drag, and vernier rockets to correct for torques and drag so as to keep the external apparatus centered about the sphere.

Whether this can be done now with an instrumented satellite is a problem that can only be answered after a considerable amount of engineering study. In any case, it is an ideal project for the first manned space laboratory. ⌗

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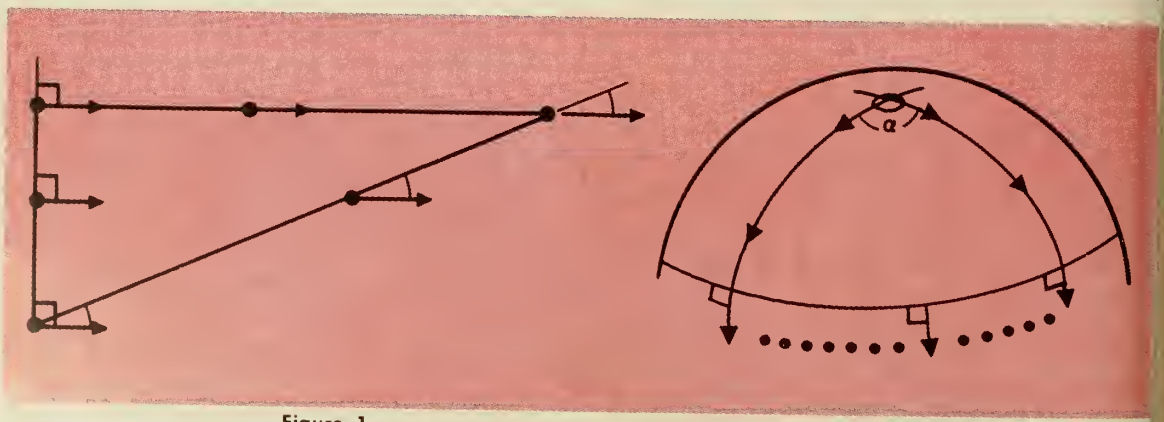


Figure 1

Figure 2

Einstein's Theory of Gravity

the other effect depends upon the fact that the earth is rotating. Both of these effects are quite complicated, but fortunately they can be explained qualitatively by analogies with more familiar effects.

• **Effect of space curvature on a satellite**—The precession of a spinning torque-free gyroscope in an orbit around a large mass is due to the non-linearities in the Einstein equations for the gravitational field.

The easiest way to look at these non-linearities is to assume that the mass of the earth, besides causing the usual Newtonian gravitational field, also causes the space around the earth to be curved. We should be familiar with the problems of operating in a curved space, since we live on a two-dimensional curved space—the earth. A straight line on the earth is the great circle route, because it is the shortest distance between two points in that two-dimensional space.

If we make a triangle with these "straight lines," we find that the sum of the angles in the triangle can range from π radians (180°) to 5 π radians (900°) depending upon the size of the triangle.

Also, the ratio of the circumference of a circle of latitude to its "radius" (distance along the surface to the North Pole) can vary from 2 π radians (360°) near the pole where the curvature of the sphere can be ignored, through 4 radians (229°) at the equator, where the "radius" from the pole to the equator is ¼ of a great circle route.

Since one of these circles has less than 360° in it, if we send a vector around this circle, the vector will not return to the starting position pointing in its original direction.

It is difficult to show this concept with a circle, but we can easily show it using spherical triangles. Suppose we are on a flat surface and we place a test vector at one corner of a triangle. Then, very carefully keeping the angle between the vector and the appropriate side of the triangle constant, we traverse the perimeter of the triangle and return to the starting point (see Fig. 1).

The test vector obviously returns to the starting point with the initial orientation. Now try this same simple experiment with a vector moving about on a spherical triangle (shown in Fig. 2). It will be obvious even to a flatlander inhabiting the surface of the sphere that the vector has precessed through an angle α as a result of its parallel translation around a closed path in the two-dimensional space. The angle α will depend upon the amount of curvature of the space, the size of the triangle and the number of times the test vector has gone around the triangle. It should be obvious that the same effect will occur for a polygon and, by extension, for a circle.

Because we are three-dimensional beings, we can see the curvature of this two-dimensional space and understand the effects. However, a two-dimensional being living on a sphere would not be able to comprehend the curvature of his space—even though he could measure it and describe it mathematically by doing experiments such as this. We are in the same trouble when we try to comprehend curvature in a three-dimensional space. We have no way of picturing three-dimensional curved space so we have to trust our measurements and mathematics.

Thus we should now understand that because Einstein's theory says that the mass of the earth causes the three-dimensional space around the earth to be curved, then a test vector (axis of a spinning satellite) moving in a circular orbit in this curved space will experience a precession of its axis.

• **Effect of the earth's spin on a satellite**—The other type of precession, that of a spinning, torque-free gyroscope in an orbit about a spinning mass, is due to the interaction between the spins of the two bodies. It was shown in a recent article in the *Proceedings of the IRE** that Einstein's theory of gravitation is directly analogous in many ways with electricity and magnetism.

For instance, the usual Newtonian gravitational field of a mass is analogous to the electric field of a charge. It was also shown that there exists a gravitational equivalent to the magnetic field which arises from moving or rotating masses. Thus, just as a rotating charged body will generate a dipole magnetic field, a rotating massive body will generate a dipole field which is the gravitational equivalent of the magnetic dipole field. And just as two magnetic dipoles interact and cause troques on each other, two rotating masses such as the spinning earth and a spinning satellite will cause gravitation-like torques on each other. This torque will cause the spin axis of the satellite to precess.

• **Precession rate**—For those who are interested, the equation for the precession of the spin axis of a spinning, torque-free satellite in an equatorial orbit about the earth is

$$\Omega = \frac{3GM}{2c^2r}\,\omega_{orbit} - \frac{GI}{c^2r^3}\,\omega_{spin}$$

where M, I, and ω_{spin} are the mass, moment of inertia, and angular velocity of the earth and r and ω_{orbit} are the orbital parameters of the satellite. The first term, which is the largest, is due to the effects of space curvature, the second term is due to the interactions of the spins of the earth and the satellite. If we put in numbers we get:

$$\Omega = (9.0 - 0.11) \times 10^{-13}\ rad/sec.$$

and we see that the spin interaction term is a small percentage of the space curvature term. This precession of about 10^{-6} degrees/day would be very difficult, but not impossible, to observe.

The problems of instrumenting a satellite to perform this experiment are not trivial. The spinning sphere could contain no internal instrumentation, since the necessary differences in densities of the apparatus would result in torques due to the gravitational fields of the sun, moon and earth which would hide the Einstein effects. Also, since there would be no way to insure that drag effects would be uniform and cause no torques, these would have to be eliminated by a protective shield.

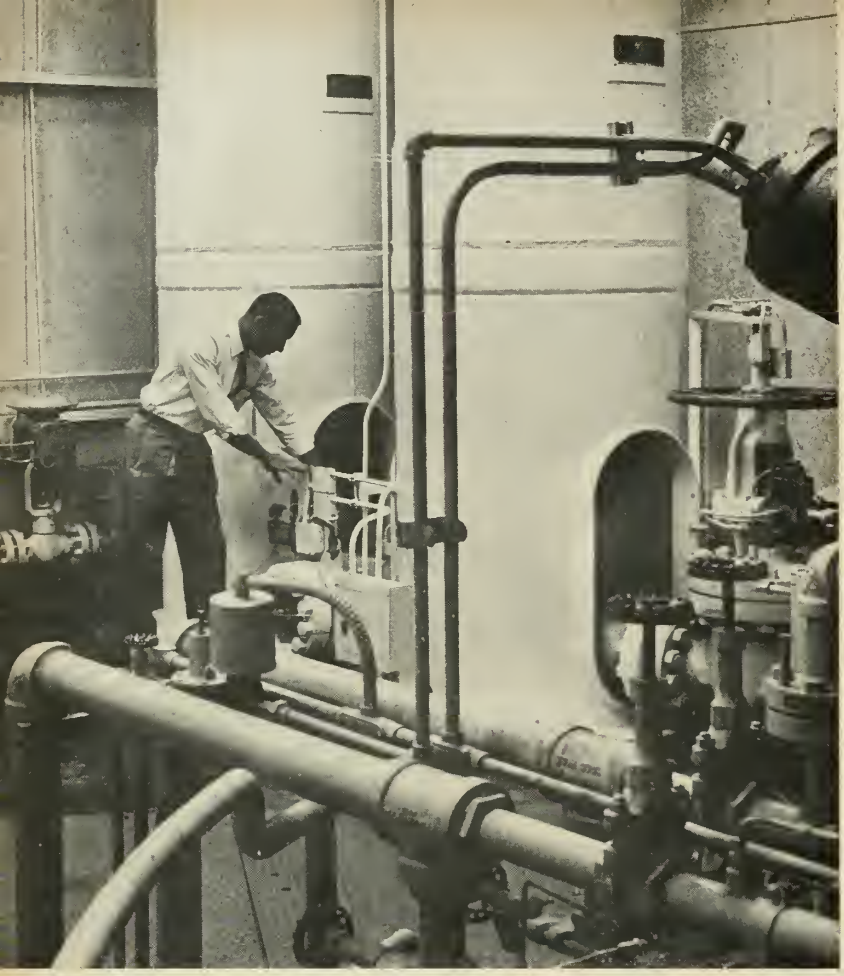
What is needed is an apparatus designed along the lines of the Orbiting Astronomical Observatory. It would contain the necessary telescopes to determine a reference frame with respect to the stars, the readout devices to determine the orientation of the spinning sphere, a large chamber in which the sphere would float protected from meteorites and atmospheric drag, and vernier rockets to correct for torques and drag so as to keep the external apparatus centered about the sphere.

Whether this can be done now with an instrumented satellite is a problem that can only be answered after a considerable amount of engineering study. In any case, it is an ideal project for the first manned space laboratory. ⌗

$2-million addition . . .

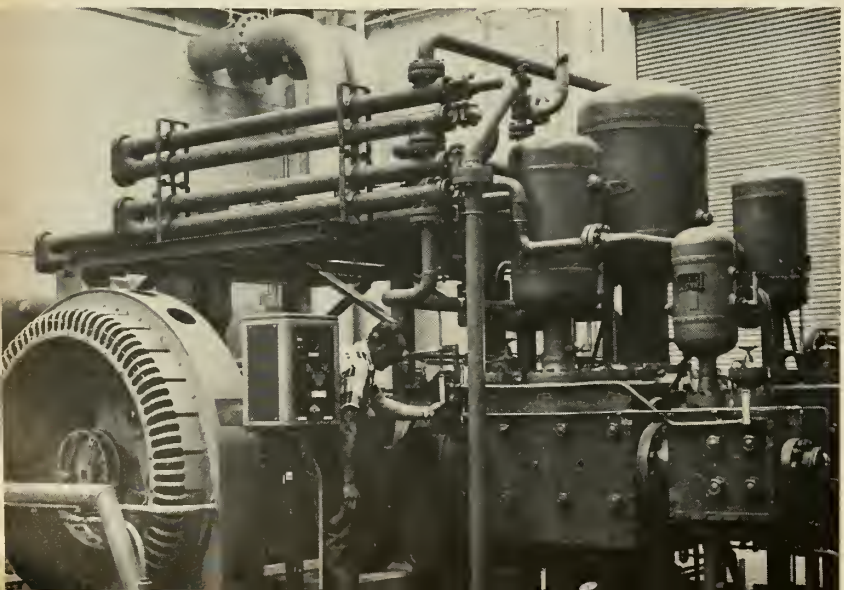
Industry

Nike-Zeus model is slated for first study in facility which uses long nozzles and small throats to obtain its elevated Mach numbers



ABOVE: *Twin air storage tanks hold 500 cu. ft. of El Segundo atmosphere at 3500 psia when ready to blow down. The tanks project through the roof. The air supply is remotely monitored and controlled from a concrete-protected control center near the test section in the same building.*

BELOW: *Air is pumped into the storage tanks for about one hour before daily runs are started, by a non-lubricated, carbon-ring compressor that supplies 1800 cfm. Entering air is not treated to alter its basic chemical composition; the compressor does not further contaminate the working medium because of design.*



EL SEGUNDO, CALIF.—Industry's largest hypersonic tunnel will begin operational testing here at the Douglas Co. when a *Nike-Zeus* model is studied at Mach 6.

The new test facility, opened last week, is a two-million-dollar addition to the subsonic and supersonic tunnel facilities at Douglas' Aerophysics Laboratory. The Mach 10 tunnel, which took three years to build, was contracted by Diversified Builders, Inc., and designed by Douglas and Sandberg-Serrell Corp. of Pasadena.

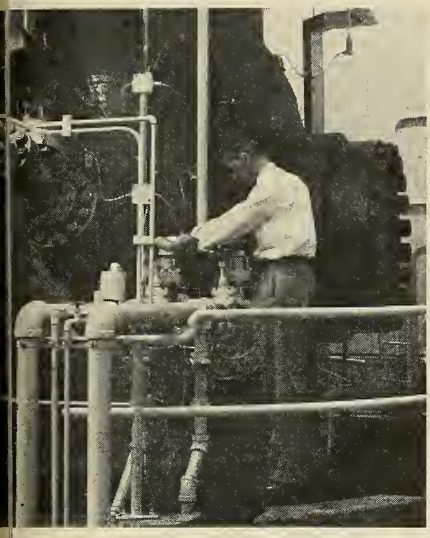
By changing supersonic nozzle sections, Aerophysics can make runs at Mach 6, 8 or 10 with atmospheric air. Higher Mach number tests are possible on helium, if some modifications are made. However, these modifications are not now scheduled.

According to Dr. James S. Murphy, Assistant Chief, the higher Mach numbers of 6, 8 and 10 for the new facility are obtained from nozzles that are quite long and very small at the throat—a fabrication problem leading to anguished moans from the machinists.

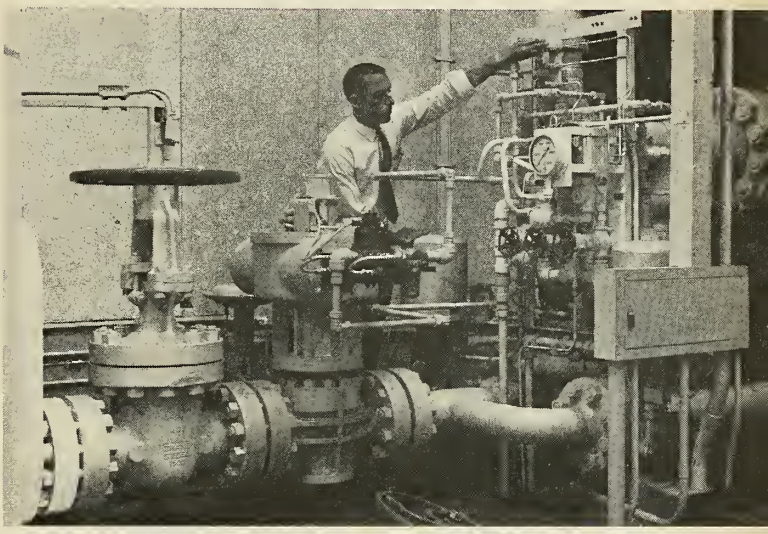
The solution adopted was to electrodeposit the walls of the nozzles around a polished aluminum mandrel of the precise curvature. This method of building up nickel to a ⅝-in. wall thickness required starting the process three to four months before delivery was expected. Because of the higher operating temperatures, the Mach 8 and 10 nozzles were built up around a throat insert machined from a beryllium/copper alloy to give sufficient structural integrity.

The heated air from the stilling chamber and intermediate spools accelerates as it flows through the nozzle throat and continues to gain velocity as it roars through the divergent portion reaching the desired Mach number.

iggest Hypersonic Tunnel at Douglas



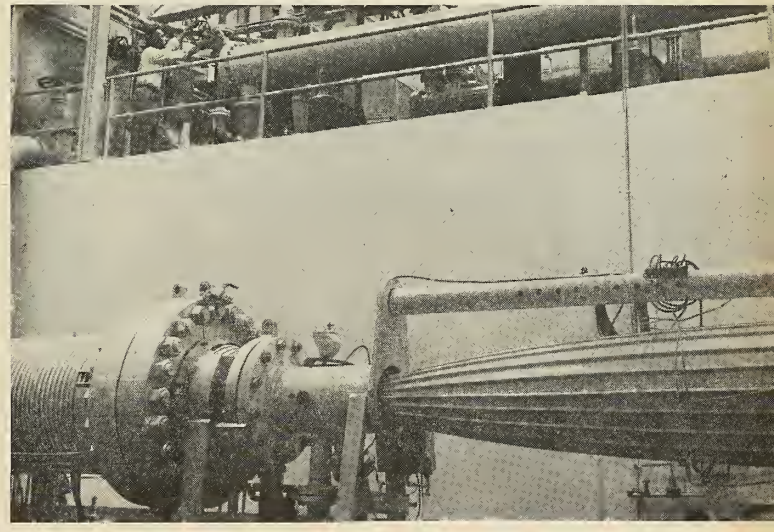
LEFT: *Next in supply system comes 100-ton pebble bed heater through which chosen portion of 3500-psi air flows in downward direction on way to therm mixer where hot and cold streams are blended to obtain required temperature in test section for the Mach number in use. The ⅜-in.-diameter alumina balls are maintained at 2800°F at top of bed.*



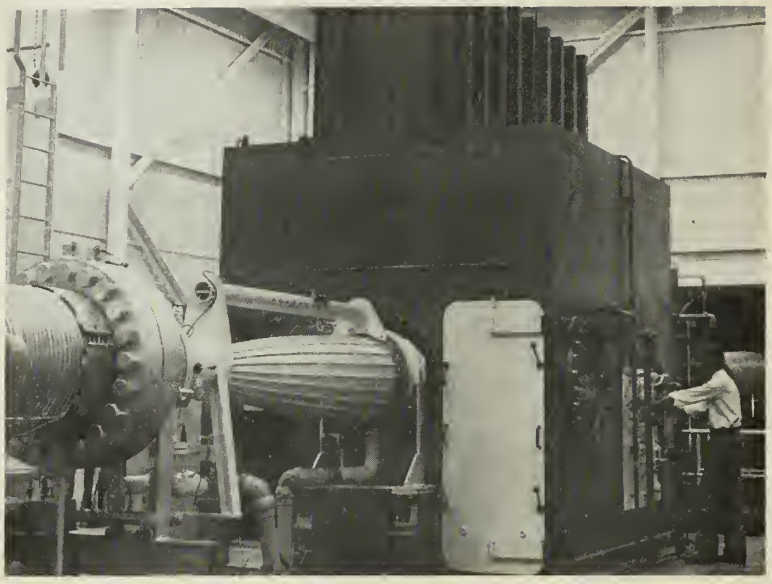
RIGHT: *Giant valves dividing high-pressure air flow between pebble bed heater and thermal mixer are automatically controlled to provide flow into test section at desired temperature. A 3000-psi hydraulic subsystem provides muscle for operating all valves and giving fast response. When ready to make run, operators in remote control center activate circuit.*



LEFT: *Upstream components—thermal mixer, mixer valve, and heater—have previously been preloaded with full-pressure air. Heated air passes through an inner wall into test area of building. It flows through a Douglas-designed stilling chamber that smooths out turbulence and other disturbances before entering the supersonic nozzle section.*



RIGHT: *Low-pressure cooling system—40 psig of water at 2000 gpm—also cools test-section plenum chamber, test-section diffuser, spools (nozzle adapter sections), and ejector plenum. High-pressure cooling system providing 400 psig at 600 gpm keeps nozzle throat, support strut for test models and diffuser throat from overheating.*



HEATER AIR FROM STILLING CHAMBER and intermediate spools accelerates as it flows through nozzle throat, gains velocity through divergent portion, reaching desired Mach number as it blasts into test chamber. Here at nozzle exit lies dimension used to classify tunnel. Mach 6 nozzle expands up to diameter of 25 in., hence term "two-foot" hypersonic tunnel. Largest diameter in present set-up—27 in.—belongs to Mach 10 nozzle.

it blasts into the test chamber.

A maximum run time of four minutes can be obtained at the lower Mach number, allowing the complete flight pattern of a missile or space system to be simulated. Remote controls rotate and roll the models as desired.

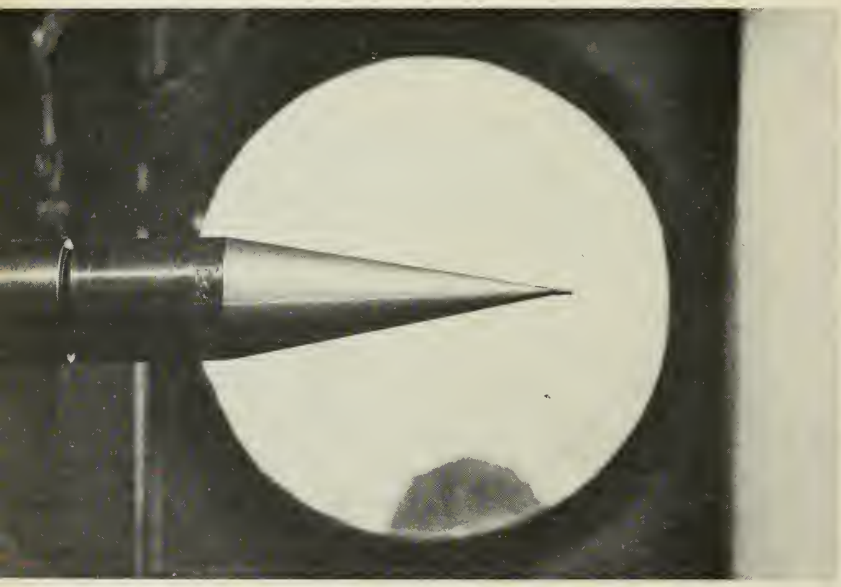
The maximum waiting period of one-half hour is required to bring the storage tanks and pebble bed heater up to operating conditions after the high Mach runs.

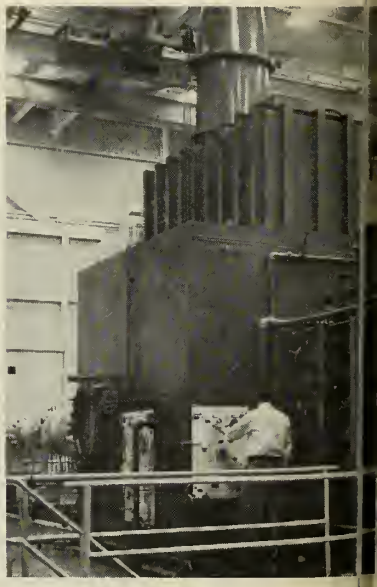
The installation is 120 ft. long, ending at a 70-ft.-high exhaust stack. From intake to exhaust, the tunnel incorporates many features of advanced engineering.

Skybolt and *Saturn* models are scheduled to follow the initial tests on the *Nike-Zeus* configuration. The "two-foot" diameter wind tunnel can handle models up to 36 in. long and 6 in. in diameter.

Air is supplied to the tunnel by a non-lubricated, carbon ring compressor the only one of its kind owned by private industry. The only other compressor like it in the United States is located at NASA's Ames Laboratory.

Water is used to cool portions of the wind tunnel which are subjected to heating effects. The tunnel was designed by Douglas and Sandberg-Serrell Corp. of Pasadena.





LEFT: *Test chamber is surprisingly large. Support strut mechanics permit tunnel operator to pitch test model up to 30° angle of attack and to roll it 200° while in hypersonic flow. Directly opposite large pressure-proof windows are used for optical observation of flow by shadow and other photography. Mass flow rate through free-jet test section at 2500 psia varies from 30-70-lb./sec.* **RIGHT:** *After completing mission, hypersonic stream enters "jet catcher" that directs it into variable-geometry diffuser within which kinetic energy of air stream converted to pressure. Flow from diffuser spills into ejecto plenum chamber leading to five air-driven ejectors, one 54-i and four 30-in.-diameter jet pumps that pull 200 to 400 lb./se of flow through the ejector nozzles of room-temperature at 9 psig, regulated down from 525-psi, 26,500-cu.-ft. storage tank f adjacent supersonic tunnel. For Mach 10 tunnel pressure rati ejectors are operated to bring plenum down around 1 to 6 psi*

ABMA Adds Vertical Test Ability

Huge new tower, other facilities, give Army what it needs to run virtually any static test of Jupiter-size birds

THE ARMY recently unveiled its ew $8.4-million vertical test facility at edstone Arsenal, Huntsville, Ala.

The facility, built for the Army Balstic Missile Agency's Test, Evaluation nd Firing Laboratory, is equipped to nable Army missilemen to conduct lmost every conceivable type of test, hort of actual flight, for missiles up to ie size of a *Jupiter* IRBM.

Most imposing structure is a vertical st stand which features a climatic hamber capable of producing temeratures from −85 to +185°F.

In addition to the test stand, with s twin test positions, the 540-acre test rea has an instrumentation and control uilding, two missile assembly and heckout buildings, environmental test uilding, attitude test stand, and several ther office and engineering buildings. n independent water supply is installed r cooling the flame deflector of the st stand and for fire protection.

The large test stand rises 88 feet igh from the base of its heavily-inforced concrete blast pit to the top f its superstructure. Twin missile ounts on the stand enable engineers o mount two complete missiles—or, n the case of two-stage missiles, the first nd second stages—side by side to perorm simultaneous or sequential tests. With this capability, a missile's in-flight ring sequence can be tested, studied nd evaluated.

The climatic chamber on the test tand allows engineers to precondition a issile and maintain that condition fter putting the missile in a vertical osition for firing. Prior to firing the otor, the huge door that forms the oor of the climatic chamber is autonatically rolled away to clear the way or the motor's blast.

ABMA plans to incorporate a highltitude simulator on the test stand at later date. This will make it possible o static-fire missiles on the stand at mulated altitudes of 70,000 to 80,000 eet.

Motor exhaust gases will be chaneled away from the test stand by deectors located below the motor exhaust ozzle. Approximately 16,000 gallons of water per minute will be passed over the deflector during tests to cool it and protect it from the high exhaust temperatures.



W. L. GRAFTON, director of ABMA's Test, Evaluation, and Firing Laboratory, stands in front of Redstone's new 88-ft.-high vertical test stand.

During operations, data from measurement points on the missile under test will be carried by cables to strip-chart recorders, oscillographs, magnetic tapes and analog-to-digital data acquisition systems in the measuring center.

The analog-to-digital systems accept separate and distinct signals from 200 points on a missile at a rate of 10,000 signals per second. Banks of automatic electric typewriters type out data received by the systems.

In addition to the acquisition center, the blockhouse contains an engineering area and firing controls. Slit windows permit full viewing of the test stand from the console panels which control the tests.

The environmental building, located in a valley one-half mile from the test stand, can also provide temperatures from −85 to +185°F.

This building—50 ft. long, 40 ft. wide and 14 ft. high—can be used as a unit or divided into halves or quarters, depending on test requirements. Each quarter of the building has its own temperature unit and controls.

A complete *Pershing* missile and its ground support equipment could be placed in the building and tested simultaneously. ⌗

An Interplanetary Space Simulator

Four-million-dollar facility being built for JPL will be used to test Mariner A and other future spacecraft

JET Propulsion Laboratory is building a $4 million space simulator which will be used to test the ultimate design of interplanetary spacecraft.

With construction expected to be completed by the end of the year, the first spacecraft tested in the chamber will be the *Mariner A*, a half-ton Venus probe that stands 8 ft. high and measures 19 ft. across with solar panels extended.

The space environment simulator is being built for JPL by a team of industrial firms headed by Consolidated Vacuum Corp. of Rochester, N.Y.

The facility consists of a 10,000 sq. ft. building to house offices, a control room, an equipment area, and the space simulator. The latter is to be a cylindrical tower 80 ft. high and 27 ft. in diameter. Within the lower part of this silo-like structure, there will be a stainless steel vacuum chamber that measures 47 ft. high by 25 ft. in diameter for testing spacecraft. The upper part of the tower houses a solar simulator unit.

The new simulator is being designed to recreate the conditions that a spacecraft will endure during a three-month space flight to the nearest planets.

It will have an intricate optical system designed by Bausch & Lomb. Artificial sunlight will be generated by 150 compact arc mercury-xenon lamps. Each lamp utilizes 2½ kilowatts of power and has a 16-inch reflector.

Light from the mercury lamps will shine downward on a parabolic mirror and reflect upward in a concentrated beam to a hyperbolic mirror. From there it is reflected downward again through the lens and into the vacuum chamber.

Once inside the chamber, the 3-ft. beam of light has to be widened to 15 ft. To accomplish this, a special 2½-ft.-diameter mirror reflects the light beam to a parabolic mirror at the top of the cylindrical chamber. From there it shines down on the spacecraft in a collimated beam, as would sunlight in space. It is expected that the system will be modified to project a 25-ft. beam.

To create a vacuum condition, a three-stage "pump down" will be utilized. The first stage will be accomplished by seven compressors ordinarily used to run JPL's 20-in. supersonic wind tunnel. Then, as this line is valved off, a "roughing system," consisting of three vacuum blowers, removes all but a small fraction of the initial air. At this point, ten oil diffusion pumps take over to produce a vacuum 10^{-6} millimeters of mercury, which is about one billionth of the atmosphere at sea level.

In order to simulate the space environment, an aluminum shroud is being built inside the JPL chamber. The shroud is made of 200 plates which are dull black to absorb heat and cooled to −310°F. This temperature is maintained by pumping liquid nitroge through small tubes running throug the shroud. With this system, 99% o the heat radiated from the spacecra is absorbed and carried away.

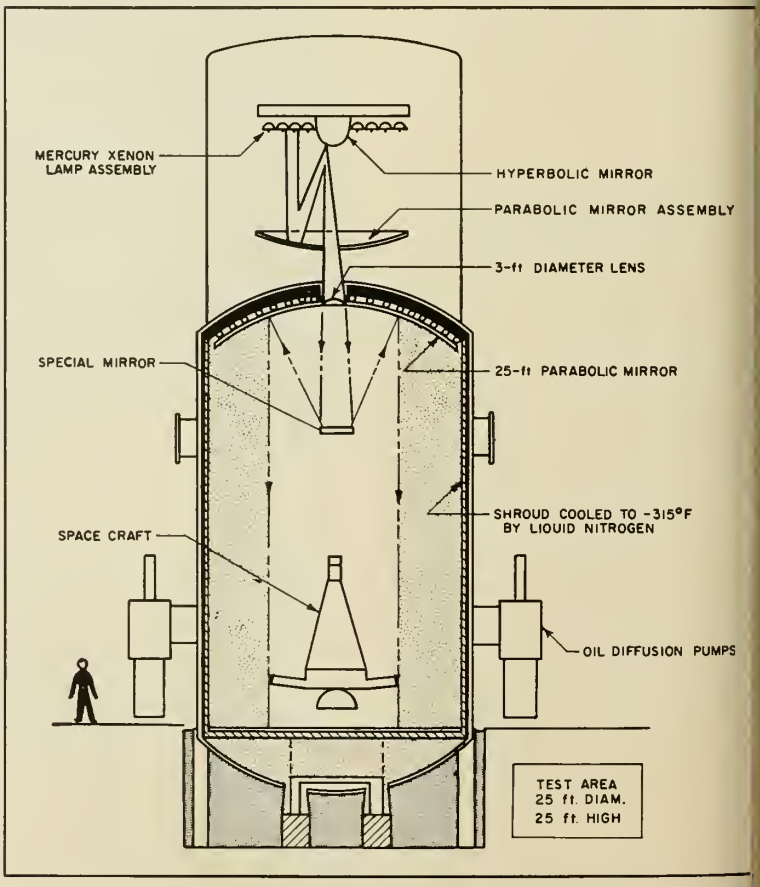
Consolidated Vacuum Corp.'s desig and fabrication team includes the fo lowing subcontractors:

Pittsburgh-Des Moines Steel Corp Pittsburgh, Pa.—Fabrication of the ste vacuum chamber and erection and as sembly of the entire facility.

Aetron Division of Aerojet-Gener Corp., Covina, Calif.—design of th building, instrumentation and externa cryogenics.

Bausch & Lomb,—design of th solar simulation system.

Tenny Engineering Corp., Unior N.J.—power system for lights.



SPACE ENVIRONMENT SIMULATOR consists of lighting system, vacuum chambe and liquid-nitrogen-cooled shroud to simulate conditions of outer space.

park Ignition

(Continued from page 25)

quid fuels—it will spark even when mersed in fluids such as insulating oil water.

Sparking in a vacuum or under pres- re results in uniform operation under idely varying conditions. With this pe of system, high spark energies are sily obtained and exciters are quite mple. The storage life of an ignition stem is quite long and the storage mperature in general is not critical.

The spark ignition system can be ft energized for a long time, if neces- ry, as compared to a pyrotechnic de- ce. Or it can be energized for a short riod. The shorter duty cycle will re- lt in a smaller system. But the system n be cycled many times. By slight anges, wide ranges of spark rates and ergies can be achieved. Sparks with ergies of 10 joules are easily obtained.

The duration of the spark is in the nge of ten microseconds. A stored ergy of one joule dissipated in ten icroseconds would give an average ergy level of 100,000 watts for that te. The material in the gap region mains as ionized, incandescent vapor r a considerably longer period.

Spark rates of 800 to 1200 sparks r second have been achieved, and gher rates are believed possible. In ost cases, the high energies and spark tes mentioned will not be necessary. ie high-rate system could be used to place the glow-plug or hot-spot ig- tion system. Spark rates of 800 to 00 sparks per second would appear be a continuous hot spot like a glow re and would be considerably hotter. ie relatively high energies used in the ow wire could be duplicated by a gh-spark-rate system. The main limi- tion of the glow plug is the long rm-up time (several seconds), where- in the spark ignition system the time g would be a few milliseconds and is edictable.

• **Radio filters needed**—One possi- e problem with the spark ignition stem could be generation of radio in- rference. Radio interference filters can fectively eliminate any interference nich would be conducted through the wer lines. Radiated interference can eliminated by adequate shielding of e igniter, exciter, and cable. In gen- al, the system will be energized for ly a few seconds during starting of e engine, making some degree of in- ference tolerable.

The power required for operation of e system would depend upon the re- ired spark rate and spark energy. The rmal input requirement would be be- een 50 and 500 watts. The system uld be powered by either 28 volt d-c or 115 volt, 400 cycle alternating current. If a d-c input is used, an interrupter such as a vibrator or switching transistor is necessary to convert the d-c to a-c.

One limitation of the creepage gap system is its short life, as compared with the high-tension system. The life is sufficient for several hundred cycles, which would allow the most complex flight to be completed and still permit testing before actual use.

In the creepage-gap plug, the semiconductor between the electrodes results in a low resistance path between the centerwire and ground, making it impossible for a static electricity charge to build up on the wire. These igniters cannot be initiated by stray electromagnetic radiation.

The spectre of spark ignition systems has been their size. The igniters sometimes caused weakening of the motor structure by the necessarily large clearance holes. Many design changes and improvements in igniters have considerably reduced their size, while maintaining reliabilty.

Function checkouts of the ignition system during a countdown are usually required. There are available igniters which detect the occurrence of sparks.

An electrical signal is produced which can be fed into a counter or a go, no-go indicator to indicate the proper operation of the ignition system. This igniter is coupled with a system which senses an output signal from the igniter and determines the spark rate and spark energy; if they are above some minimum value, it will produce a go signal.

• **Telemetered spark**—The primary feature of this system is in determining the actual occurrence of the spark at the gap. This device could be used during the countdown to check out the complete ignition system and could be used at firing as a safety device—in that the fuel control valves could not be opened until a "go" signal was received from the ignition system. A system of this type could be used in other stages and could telemeter information back to earth on the operation of the ignition system.

If a shot failed, the spark monitor system would help to pinpoint the cause —whether it were the ignition system, fuel control system, etc.

Perhaps the ultimate in spark ignition systems is the integral igniter. This device is a complete ignition system in a single package. The igniter and exciter are combined in a single unit and the interconnecting cable is eliminated. The weight of this system is less than 0.75 lbs.

Units have been subjected to ambient soak temperatures of −110° to 250°F and ambient operating temperatures of −110° to 200°F with wider limits possible. The a-c input units are less affected by temperature than the d-c input units because of the transistors used in the latter.

The integral igniters contain no moving mechanical parts or fragile glass components. Silicon rectifiers are used in place of glass rectifiers. The discharge tube is a strong ceramic tube. On d-c input units, switching transistors are used instead of vibrators. For temperatures below 165°F, germanium transistors are employed, while applications above this temperature involve silicon transistors.

In a recent test, an integral igniter was placed in a vacuum chamber and tested at various vacuums simulating altitudes exceeding 100 miles. The unit was maintained at this condition for five hours and operated properly at all conditions. The lowest pressure reached was 0.07 microns of mercury absolute. This test disproves statements that spark ignition cannot be used in a vacuum.

The integral igniter can be built with an internal heat barrier to protect the electronic components from the high temperatures in the gap region. One model igniter can withstand 900°F at the igniter seat for four minutes with a 165°F ambient temperature. This heat barrier is necessary in multiple-start systems and adds about one inch to the overall length of the igniter. For single-start systems the heat barrier is left out; the result is a smaller, lighter unit. This version can, of course, be tested many times, but it will withstand only a single hot firing.

The use of spark ignition in liquid-fuel engines will probably increase. Igniters will become more reliable and will decrease in size. Exciters will decrease in size and weight, and will become capable of operating over temperature variations of −300°F to 600°F as high and low temperature components become available. In addition, exciters will be able to withstand extreme mechanical shock and vibration. Ignition systems in general will be more reliable, and provide higher energy outputs. Spark ignition may also have limited use in solid-fuel engines. ⌗

British Weather Rocket Approaches Testing Stage

BRISTOL-AEROJET LTD.'s answer to *Arcas* will soon begin static testing.

The as-yet-unnamed low-cost high-altitude meteorological rocket is designed to carry an instrument pack to a height of 200,000 ft. After separation, the pack will descend by parachute.

The rocket's launch system consists basically of a 32-ft.-long tube, 24 in. in diameter, supported on a hinge and raised by a hydraulic strut. ⌗



international

Sweden Adds Missile Punch on Lan

by Bernard Poirier

BOFORS AND SAAB have introduced five new missiles into Sweden's arsenal. They include an improved *Bantam* antitank version, the *Erika* ship-to-underwater ASW missile, and three versions of Hughes *Falcons* with infrared-homing and radar guidance.

Following year-long negotiations, the latest SAAB Draken fighter can now carry air-to-air and air-to-surface *Falcons*. New radome electronics and fire control to support this sophisticated armament are believed to be based on a Ferranti Airpass IIC design and manufactured in Sweden.

The improved *Bantam* is undergoing evaluation trials and has a new "stepped-fin" design with higher performance. If trials prove successful, MISSILES AND ROCKETS was told, the weapon will go into series production before the end of the year. This would cap Bofors' gamble on a private venture into missile system design.

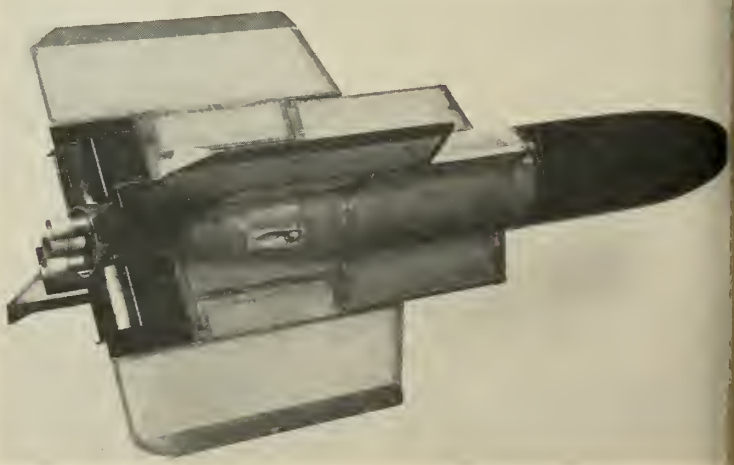
The *Erika*, also a Bofors offering, is a solid-fuel antisubmarine weapon which can be fired in salvos with 50-to-60-sec. intervals between rounds. Adjusting the azimuth for each unit rapid-fired from a 16,300-lb. four-barrelled launcher reportedly minimizes dispersion of the 220-lb. warheads.

The 6.5-ft. *Erika* has an all-up weight of 550 lbs. and a range over one mile for detonation by a mechanical fuze at 27 fathoms. Swedish sources say a new proximity fuze will be tried during the next scheduled sea trials.

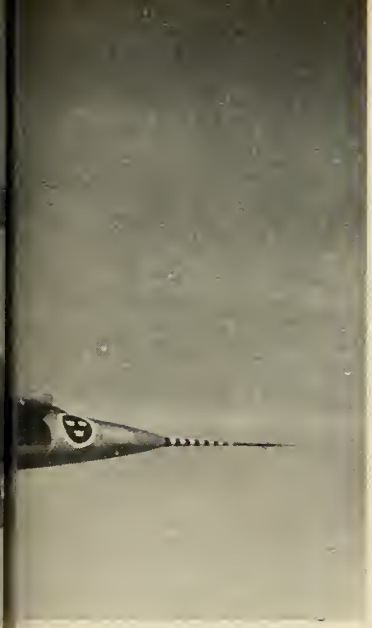
Sweden's Forsvarsstaben agency announced last November that it was studying and negotiating for Mach 2 *Falcons* with ranges around 5 miles. Versions believed to be included in the Hughes export deal are the *GAR-3A, GAR-4A* and the *GAR-11*. Versions weighing over 220 lbs. are mounted at three points below the Draken fuselage, or one each can be mounted on a wing. There can be as many as seven mou ing points for lighter *Falcon* versio

One of the main features of the a vanced missile fire control built into t SAAB 35 Draken is the Pilot's Atta Sight (P.A.S.) located at eye-level the cockpit. It can be coupled to lock-on radar which searches or can hand-controlled. (M/R, Jan. 9, p. 37

• **Bantam details**—The new, 2.7- wire-guided and gyro-stabilized *Bant* with 15.7 in. fins has a 6600-yd. ran



NEW BANTAM DESIGN is here revealed by Bofors AB for the first time. former, experimental Bantam did not have this stepped-fin configuration.



EW SAAB DRAKEN fighters can carry r-to-air or air-to-surface Falcons.

ea and Air

ıd a firing weight of 13.2 lbs. It has ı 8.8-lb. missile container and a 4.4-lb. ɔntrol unit. In recent tests the weapon enetrated 16-in. armour and operated etween −40°F and +140°F.

The aft wing corners are bent to ake the missile roll in flight. When cked in the container the wings are lded against springs. The material the airframe is largely laminated erglass-reinforced plastic.

Normally the *Bantam* has a hollow-arge warhead. This can easily be changed, however, if the mission re-ires it. The missile body contains the ttery, guide-wire spools, transistorized gnal receiver, powder-energized gyro ıd tracers.

The gyro starts when the missile is red by electrical ignition of a powder arge. The electrolyte container bursts hen ignition occurs and immediately tivates the gyro wet-cell battery. This ethod gives the battery an unlimited orage life. Use of gyro stabilization dicates that the missile has some self-ɔntrol enabling it to level off for quick ecovery following initial thrust.

The *Bantam's* tracers help the gun-er follow the 190-mph flight towards ıe selected target. Bofors says the new *antam* has the accuracy to kill tanks in ne shot, and that several missiles can e set up on a vehicle or on the ground. peration still is coordinated by one ɔntrol unit, but with a special set of ables and a selector box. ⌗

soviet affairs

By Dr. ALBERT PARRY

Red rocket experts were afraid

last December that their failure to bring back from its orbit *Spacecraft III*, with dogs Pchelka and Mushka and other, smaller animals aboard, "would leave an unfortunate impression" on Major Yuri Gagarin and his fellow officers then in training for space flights.

This is revealed by Gagarin in *Pravda* for June 7. "However," Gagarin reminisces, "we understood that this was not inevitable, but only an accident; that life is far more complex than you suppose it to be. We were sorry about the loss of that satellite, in which such great funds had been invested. But in such a grandiose business, extra expenditures are unavoidable."

Nevertheless, several paragraphs later, returning to the loss of the rocket launched on Dec. 1, Gagarin speaks of "the somewhat bitter sediment, left by the loss of Pchelka and Mushka, the feeling which we feared to confess to ourselves, but which existed just the same." He assures the Soviet reader that this "sediment disappeared completely" in subsequent months, when the trainees heard about other, more successful Russian launchings, particularly the firing of the piggy-back rocket to Venus.

Daphne plants as astronauts' food

are discussed by Professor P. K. Isakov in a recent article, "The Era of Space Flights," in the Moscow *Trud*. He specifies the daphne plant growing in ponds and "feeding on algae," and writes of "recently published researches" conducted on this plant as a possible mainstay of the menu for long space flights. "They multiply quickly . . . they contain all the necessary nutritional values: albumens, fats, carbohydrates, mineral elements, and vitamins." Professor Isakov, a candidate of the biological sciences, is chairman of the Soviet State Committee on Cosmic Medicine and a Stalin Prize winner.

Rocket fuel successes

of the Soviets can be attributed to Professor Nicholas N. Semyonov "and his team," according to an article by N. Riazantsev in *Novoye Russkoye Slovo*, a New York Russian (anti-Soviet) daily. The émigré declares that Semyonov and his collaborators "brilliantly resolved this problem which still has not found its final solution among Western specialists"; it was Semyonov and his men who produced the fuel responsible for greater rocket thrust than America and her allies have so far achieved. (Professor Semyonov, winner of a 1958 Nobel Prize in physical chemistry, is known for evolving and explaining a complete and consistent theory of explosions and combustions, most of his basic work dating back to the 1920's.)

Auschwitz as a rocket-fuel base

is mentioned in *Izvestia* of May 31. In his article "Triumph of Life," A. Plyushch relates that among the Nazi war factories surrounding the mass-death camp of Auschwitz one giant "combinat" produced fuel for the *V-2* rocket through much of World War II.

Following the Nazi defeat, the Polish government under Soviet guidance restored the chemical factory. Some 240 Polish chemists and technicians were sent to the Soviet Union "to raise their qualifications" in Russian technicums and universities. They are back now in the former rocket-fuel "combinat," where phenol, synthetic rubber, and liquid oxygen are now produced, among a total list of 86 chemicals and plastics.

A national Space Age museum

and planetarium, dedicated to the memory of Konstantin E. Tsiolkovsky, will soon be erected in Kaluga, central Russia, near the park which bears the name of the pioneer rocket-man and contains his grave. A nationwide design contest was won by a team of Moscow architects headed by B. Barkhin.

NASA

$1,227,138—Chrysler Corp.'s Missile Div., Huntsville, Ala. and Detroit, for qualification and reliability testing on various engine, hydraulic, mechanical and structural components of the *Saturn* booster.

$589,000—Pratt & Whitney's Connecticut Aircraft and Nuclear Engine Laboratory, Middletown, for construction of a test stand for development of space radiators and condensers at Lewis Research Center.

$164,000—Inscho's Mechanical Contracts, Birmingham, Ala., from Marshall SFC, for expansion of water system that supplies test tower on which *Saturn* booster is static-fired.

$132,226—Bechtel Corp., Vernon, Calif., for development of design criteria of facility for static-testing the J-2 liquid hydrogen-liquid oxygen engine to be used to power the S-II stage of advanced version of *Saturn*.

$102,000—Micro Gee Products, Inc., Culver City, Calif., for specialized testing equipment for missile and spacecraft guidance systems.

$80,000—North American Aviation, Downey, Calif., for 2 *Little Joe* airframes.

$61,200—Whitmore Electric Co., Miami, for construction of electric duct work for the second *Saturn* complex, Cape Canaveral.

$54,000—General Dynamics/Convair, San Diego, Calif., for establishment of design concepts for "meteoroid bumpers" for protection of space vehicles in collision with meteoroids.

Telecomputing Corp., Los Angeles, from General Electric, for precision angle measuring instruments for the Orbiting Astronomical Observatory *(OAO)*. No amount disclosed.

DEPT. OF DEFENSE

$7,008,165—Raytheon Co., Lexington, Mass., for feasibility study of a new concept for ballistic missile defense (ARPAT).

MISCELLANEOUS

$3,275,000—Massachusetts Institute of Technology, Cambridge, from Advanced Research Projects Agency, for materials research.

$408,750—Electronic Associates, Long Branch, N.J., from General Electric's Missile and Space Vehicle Co., for 3 heat-transfer general-purpose analog computers.

$68,000—Rocket Power, Inc., Mesa, Ariz., from Sandia Corp., Albuquerque, N.M., for *Gila III* solid-propellant sled rockets.

NAVY

$1,217,396—Remington Rand Univac Div. of Sperry Rand, St. Paul, Minn., for continuation of studies and applied research leading to design of an ultra-high-speed data processing system.

$853,300—Consolidated Welding and Engineering Co., Chicago, for bow sonar domes.

$350,142—Arma Div., American Bosch Arma Corp., Garden City, N.Y., for miniature gyro compass equipment.

$247,670—Radio Corporation of America, RCA Laboratories, Princeton, N.J., for studies directed toward development of thermoelectric materials, fabrication and thermoelectric generator design for conversion to electric power by thermoelectric means.

$221,128—Project Fabrication Corp., College Point, N.Y., for engineering services and transportation for liquid oxygen, liquid nitrogen plant.

$130,977—Telectro-Mek, Inc., Fort Wayne, Ind., for design, development, and fabrication of 2 gross-thrust computers.

$61,676—Lasko Metal Products, Inc., W. Chester, Pa., for unassembled components of *Sidewinder* guidance and control containers, rocket motor containers and warhead containers.

ARMY

$34,580,102—Sperry Rand Corp., New York City, for production of *Sergeant* missile and related ground support equipment; research on the *Sergeant* missile system; and a classified contract. (Four contracts.)

$7,787,000—Martin Co., Baltimore, for hardware and development of *Pershing* ballistic missile system. (Two contracts.)

$6,221,230—General Dynamics/Pomona, Calif., for continued R&D on *Mauler* weapon system.

$5,913,177—Raytheon Co., Waltham, Mass., for concurrent and replenishment repair parts for *Hawk* missile. (Two contracts.)

$4,964,937—Raytheon Co., Waltham, for procurement of radar and production of radar test equipment for the *Hawk* missile system. (Two contracts.)

$4,435,032—Western Electric, Burlington and Winston-Salem, N.C., for production of ground guidance and control equipment for *Nike-Hercules*.

$3,196,278—Fruehauf Trailers' Missile Products Div., Los Angeles, for trailers and enclosures for the *Sergeant* missile system.

$2,062,326—Thiokol Chemical Corp., Bristol, Pa., for production of rocket and missile motors at Longhorn Ordnance Works, Marshall, Tex.

$1,150,000—Western Electric Co., New York City, for further development of the *Nike-Zeus* antimissile missile system.

$1,211,453—Aerojet-General Corp., Covina, Calif., for fabrication, installation and checkout instrumentation for a solid-propellant rocket motor test facility at Redstone Arsenal.

$1,093,859—Yuba Mfg. Div. of Yuba Consolidated Industries, Benicia, Calif., for blast valves and blast dampers for *Titan II* missile launch facilities.

$506,000—Radiation, Inc., Melbourne, Fla., for development of a digital data system for use with an experimental prototype of the *Nike-Zeus* defense center.

$471,500—Avco Corp., Everett, Mass., for research in re-entry physics.

$299,772—Universal Match Corp., St. Louis, for *Pershing* Erector Launcher Guided Missile Transportable (TEL).

$200,000—Dresser Electronics, SIE Div., Houston, from Martin/Orlando, for telemetry signal conditioning equipment in the *Pershing* missile program.

$162,141—Philco Corp., Lansdale, Pa., for production engineering measure to develop automatic production equipment for manufacture of silicon-surface alloy transistors (SAT).

$87,193—Applied Design Co., Tonawanda, N.Y., for design, development, and fabrication of 2 prototype containers for *Sergeant* body assembly and 2 prototype containers for *Sergeant* rocket motor, including technical data and final summary report.

AIR FORCE

$87,700,000—Pan American World Airways, f operation and maintenance of the Atla tic Missile Range.

$14,500,000—Paul Hardeman Co., Los Angele for production of propellant loading sy tems for the *Titan* ICBM.

$5,683,345—Douglas Aircraft Co., Santa Mo ica, Calif., for components, ground su port equipment, spare parts, and en neering and technical data for the Ge rocket.

$3,000,000—Budd Electronics, Div. of T Budd Co., Inc., Philadelphia, for modi cation of NORAD gap-filler radars the Semi-Automatic Ground Environme System (SAGE).

$2,500,000—General Dynamics Astronautic San Diego, Calif., for 3 *Atlas* missile pr cedure trainers.

$1,500,000—Bendix Radio Div., Baltimore, f 6 AN/GPA-27A radar set groups; 2 AN GPS-57A radar set groups.

$1,000,000—Itek Laboratories, Lexington Mass., for research and study of wha will happen to large, highly precise opt cal systems when hurled into space.

$850,000—Page Communications Engineer Inc., Washington, D.C., for engineerin furnishing and installing a transportab troposcatter link for the Atlantic Missi Range.

$737,363—Dynatronics, Inc., Orlando, Fla., f range safety officer's console and displa systems, 2 ea., and telemetry PCM tap copy system. (Two contracts.)

$635,618—Reeves Instrument Corp., Garde City, N.J., for on-site and off-site dep level maintenance for the AN/MSQ- radar bomb scoring system.

$630,015—Collins Radio Co., Cedar Rapid Iowa, for single sideband communicatio equipment for the Atlantic Missile Rang

$477,550—Motorola Military Electronics Div Scottsdale, Ariz., from Philco Corp., fo precision satellite tracking equipmen (Two contracts.)

$345,048—Del Mar Engineering Laboratorie Los Angeles, for 13 target systems, ex ternal tow rockets and missile, Typ A/A37U-6.

$300,000—Coleman Engineering Co., Los An geles, from Convair, Ft. Worth Div. o General Dynamics, for continuation o testing of escape capsule of *B-58* bombe

$202,488—Arnoux Corp., Los Angeles, for tele metry decontamination systems.

$196,845—Hughes Aircraft Co., Culver Cit Calif., for analytical and experiment studies to develop ion engine groun testing techniques.

$114,422—Itek Laboratories, Div. of Ite Corp., Cambridge, Mass., for 15 frequenc standards.

$106,762—Sperry Microwave Electronics Co Div. of Sperry Rand, Clearwater, Fla for radar beacon checkout system.

$100,000—General Electric's Defense System Dept., Syracuse, N.Y., for test equipmen to support *Atlas* organic maintenanc plan for FY '60; $70,000—GE's Missile Space Vehicle Co., Philadelphia, for ini tial MGE/OGE spares and depot overha spares for *Atlas* General Electric peculia Mark IV re-entry vehicle subsystem.

$92,292—Milgo Electronic Corp., Miami, fo data converters and Mod. IV sequencer.

Measurement Systems, Inc., So. Norwalk Conn., for development of an infrare polar recording nephelometer. No amoun disclosed.

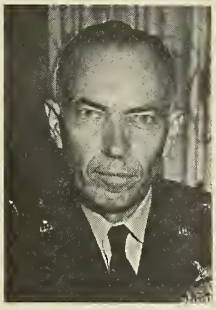
names in the news



SHERMAN



SCHUTZ



PRESTON



SNOW



FELLING

Dr. Christopher Sherman: Experiental plasma physicist, joins Geophysics orp. of America, Bedford, Mass., where will conduct studies on novel systems r space vehicle propulsion. Dr. Sherman rmerly was senior scientist for Avco orp.'s Research and Advanced Developent Division.

Lt. Gen. Clovis E. Byers, USA (Ret.): amed vice president-Washington, D.C., ffice for General Telephone & Electronics orp., succeeding **Adm. Frederick J. Bell,** SN (Ret.) who will continue as a conltant.

Gerald C. Schutz: Formerly with Benx Systems Division, named vice presint-engineering and sales, Vitro Eleconics, a division of Vitro Corp. of Amera.

Donald W. Bodene: Joins the Product evelopment Dept. of The Beryllium orp., Reading, Pa. Formerly Bodene was hief metallurgist at Rolle Mfg. Corp., id metallurgical engineer at the Alumim Co. of America.

Cledo Brunetti: Formerly with Grand entral Rocket Co., rejoins one of its rent companies, Food Machinery and hemical Corp., as special assistant to the resident. **John J. Crowley,** vice president id formerly assistant general manager, amed acting general manager of GCR.

W. L. Young: Former manager of opations of Convair's Astronautics Divion, joins Guidance Technology, Inc., Los ngeles, Calif., as director of manucturing operations.

Dr. Howard L. Recht: Named chief of ectrochemistry laboratory; **Dr. Richard Smith,** chief of solid state devices labratory; and **Karl A. Sense,** research sciitist in the energy conversion section of stropower, Inc., Cost Mesa, Calif.

Benjamin F. Rose, Jr.: Manager of erojet-General Corp.'s AEtron Division, ovina, Calif., elected a vice president of e corporation.

Eugene F. Peterson: Elected vice present of marketing, consumer and industial products of International Telephone and Telegraph Corp., New York City. Prior to joining IT&T, Peterson served in various executive capacities with General Electric Co. for 27 years.

Verser Gillon: Named manager of program planning for General Dynamics division at Fort Worth, Texas.

H. Holt Apgar: Named product supervisor at Vitro Chemical Co., a division of Vitro Corp. of America, New York City. Apgar formerly was with S. Wimpie Associates, Inc., and Sylvania-Corning Nuclear Corp.

William E. Roberts: Former executive vice president of Bell & Howell Co., named president and chief executive officer of Ampex Corp., Redwood City, Calif., succeeding **George I. Long, Jr.,** who will continue as a director.

Maj. Gen. Joseph J. Preston: Named commander of Strategic Air Command's 1st Missile Division, Vandenberg AFB, Calif. The General's previous assignment, as Commander of the 22nd Air Division with Headquarters at Malmstrom AFB, Mont., was to lay the groundwork for the ICBM *Minuteman* program. Gen. Preston replaces **Gen. David Wade,** who will take command of the Sixteenth Air Force with headquarters in Torrejon, Spain.

Neil M. Blair: President of RF Products Division of Amphenol-Borg Electronics Corp., named president of FXR Division. **Henry Feldmann,** chairman and president of FXR, Inc., before it was merged recently with Amphenol-Borg, will continue as chairman of the FXR Division.

E. Nevin Kather and **John T. Thompson:** Former division general managers, elected vice presidents of Raytheon Co., Lexington, Mass. **Kenneth M. Lord** elected vice president-manufacturing and purchasing; **Richard P. Axten** elected secretary.

E. J. Venaglia: Former manager of Sperry Rand's Microwave Electronics Co., appointed manager of Sperry's System Group program to convert two 11,000-ton troop carrier ships into mobile missile-tracking stations (MARS) for use on Atlantic Missile Range.

Mel Snow: Named manager of quality control for Pan American Airways' Guided Missile Range Division. Prior to joining Pan Am, Snow was procurement manager for Westinghouse Atomic, Pittsburgh, Pa.

James N. Waggoner, M.D.: Appointed aerospace medical director for The Garrett Corp., Los Angeles, Calif. Previously, Dr. Waggoner was medical director for Garrett's AiResearch Mfg. Division, and was one of nine elected a Fellow by the Aerospace Medical Association for his outstanding contribution to the aerospace medical field.

T. R. Hensley: Named plant engineer for Solid Propellant Operations, Rocketdyne Division of North American Aviation, Inc. at McGregor, Tex. Hensley replaces **W. J. Mundy,** who returns to the company's corporate offices in Los Angeles.

Warren R. Yuenger: Appointed research scientist by Ling-Altec Research Division of Ling-Temco Electronics, Inc., Anaheim, Calif. Before joining Ling-Altec Research, Yuenger was with Cubic Corp.

Dr. William E. Felling: Named director of scientific liaison-universities and professional societies for Raytheon Co., Lexington, Mass. Previously Dr. Felling was a research scientist for McDonnell Aircraft Corp.

Capt. Richard S. Garvey, USN: Named to head the Pacific Missile Range Safety Dept., Point Arguello, Calif., succeeding **Capt. W. P. Murphy,** USN, who will attend the Naval War College, Newport, R.I.

King H. Dendy: Former president of Microsecond Electronics, Inc., joins PCA Electronics, Inc., Hollywood, Calif., as vice president.

Dr. Garland M. Branch and **Roger J. Segalla:** Named consulting microwave physicist and radio frequency measurements specialist, respectively, in the research section of General Electric's Superpower Microwave Tube Laboratory, Schenectady, N.Y. Also named to the advanced engineering section of the Laboratory were: **Charles W. Belichner,** circuitry engineer; **Jerome J. Hamilton** and **W. John Pohl,** design engineers.



Propellant Impulse Bomb

Technoproducts Inc. is adding the Model 601 Impulse Bomb to its line of standardized test equipment for the rocket propellant industry. The Model 601 Impulse Bomb has a nominal volume of 5 cu. in., and is rated for a maximum working pressure of 30,000 psi. It was developed primarily for testing high-energy solid propellants and liquid monopropellants.

The Model 601 Impulse Bomb is supplied complete with pressure transducer and firing circuit. The only additional equipment required is a suitable recording system to receive the output of the transducer.

Circle No. 225 on Subscriber Service Card

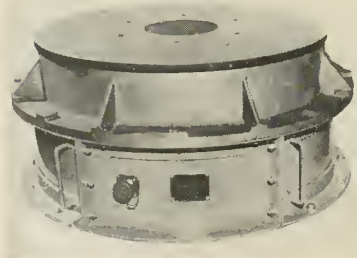
Printed Circuit Mounts

A clamp to shock-mount printed circuit cards is available from Moore Associates, Inc. The printed circuit cards are held firmly in place with the clamp, maintaining proper electrical and mechanical connection with the connector socket. The clamp is a metal strip, as long as the card, with a U-shaped notched retainer at one end.

Circle No. 226 on Subscriber Service Card

Antenna Pedestal

Antlab, Inc. has developed a versatile Azimuth Antenna Pedestal (Model 3606) so lightweight that it can be used at the top of a tower as well as at lower levels. The unit, weighing only 300 lbs., is designed so that a mast of up to 5½-in.-diameter may be installed through the vertical axis by the user. This auxiliary mast shares the over-turning load on the support-bearing from such ambient conditions as wind force and antenna weight. Compact in design and ruggedized for severest of atmospheric conditions, the pedestal develops a torque of 1000 ft./lbs. at 1½ rpm. The pedestal may be either servo-controlled or operated electro-manually.



Circle No. 227 on Subscriber Service Card

Liquid Interlock Switch

The Cat. 325 Liquid Flow Switch, specifically designed for use as a protective device to operate a switch when the flow of a fluid is a critical factor for operating efficiency, is available from Henry G. Dietz Co. Featuring low pressure drop, high current capacity, and immunity to shock and vibration, it employs no diaphragms or moving shaft seals.

Circle No. 228 on Subscriber Service Card

Coaxial Ferrite Isolator

A broad-band coaxial ferrite isolator featuring very high isolation-to-insertion characteristics is in production at Kearfott Division of General Precision, Inc. The model consists of coaxial construction with permanent magnet transverse field and ferrite sections built into the unit. The connectors used on the isolator are Type "N" female coaxial. These can be changed to fit customer requirements.

Circle No. 229 on Subscriber Service Card

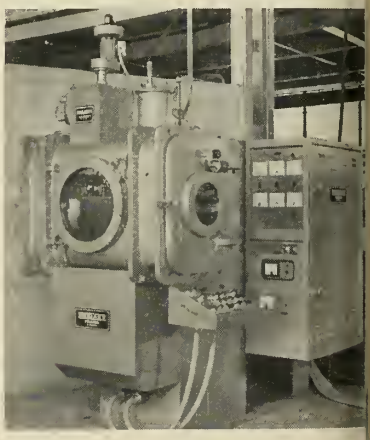
Hi-Strength Film Adhesive

A high-strength thermosetting film adhesive which can be cured at low pressures for metal-to-metal bonding and metal honeycomb sandwich construction is being marketed by Adhesives, Coatings and Sealers Division, Minnesota Mining and Manufacturing Co. Scotchweld Brand AF-110 can be cured under pressure in the range of 10 to 25 psi. The only pressure necessary is that required to provide contact between the parts being bonded and to keep the parts properly aligned. The adhesive exceeds the requirements of military specification MIL-A-5090D-Type 1 for metal-to-metal bonding and MIL-A-25463-Type 1, Class 2 for honeycomb sandwich construction.

Circle No. 230 on Subscriber Service Card

Electron Beam Welder

Sciaky Bros. Inc. is marketing a newly designed electron beam welder, Model VX-20-30-48. The vacuum chamber measures 20 in. wide x 30 in. high x 48 in. long. Complete gun mobility takes full advantage of the internal chamber dimensions. The electron gun is provided with traverse motion (Y axis) and vertical motion (Z axis) powered by Sciaky's speed and position servo-control. This control also effects longitudinal motion (X axis) to the internal work table. Numerical control is easily adapted to the Sciakydyne Control concept.



Circle No. 231 on Subscriber Service Card

Photoelectric Sensors

Solar sensors, designed for operation in a space environment, are being produced by Ball Brothers Research Corp. These photoelectric sensors are used primarily to provide high-performance servo control of rocket and satellite

›rne sun trackers. Solar sensors can be rnished with various angular charac-ristics for coarse servo control, fine rvo control, spin detection and aspect termination. An EA-3 amplifier has en built to condition signals from the nsors for either telemetering or servo plications. The amplifier is a com-etely transistorized, low-drift device. s a single-ended amplifier, the output nge is from 0 to 5 v for telemetering 2.5 v +2.5 v for servo control.

Circle No. 232 on Subscriber Service Card

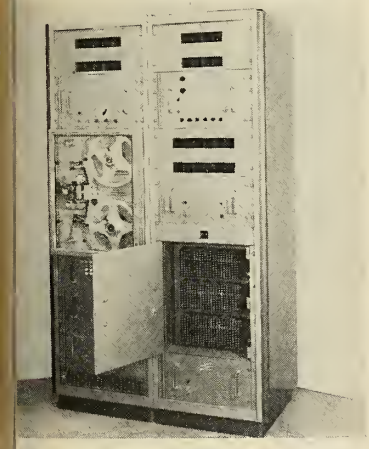
i-Temp Tape

A pressure-sensitive tape designed reflect extreme heat from motors, res and delicate structural parts is ailable from Minnesota Mining and anufacturing Co. Called "Scotch" and No. Y-9050 heat reflective tape, is capable of performing continuously temperatures of 500 to 600°F, and n withstand more than 3000°F of diant heat for short periods.

Circle No. 233 on Subscriber Service Card

adiotelescope Controller

A digital data system designed for e precise control of a radiotelescope available from Datex Corp. The sys-

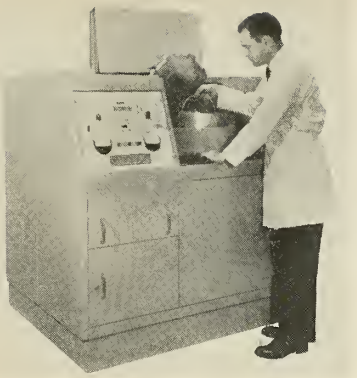


m will check the actual position of e radiotelescope antenna against a re-ıired position recorded on tape and ntrol antenna movement so that the ıtenna is precisely positioned to stay ı the signal area. Except for a high-eed perforated tape reader, the sys-m has been designed from standard atex modular system components, in-uding K-111 Control Chassis, DC-113 igital Clock, and PC-104 Programer.

Circle No. 234 on Subscriber Service Card

adiflo Leak Detector

A Type 24-510 Radiflo Leak Detec-r for high-efficiency production-line sting is available from Analytical & ontrol Division of Consolidated Elec-odynamics Corp. Capable of testing ermetically sealed components for



leaks in the 10-11 atm cc/sec range, depending upon component size, it can test up to 10,000 transistors in a single activation cycle of less than an hour. Either GO-NO-GO or quantitative inspection can be performed on individual components with a scintillation counter which measures the radiation level. The presence of tracer gas is indicated on an auxiliary rate meter.

Circle No. 235 on Subscriber Service Card

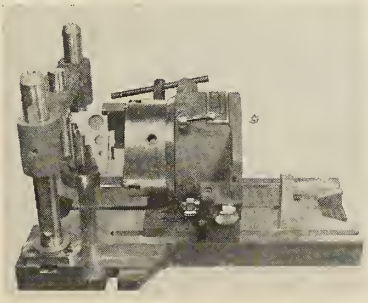
Temperature Chamber

Wyle Laboratories has designed a liquid CO_2-cooled miniature high-low temperature chamber, Model C-106, for use in environmental simulation tests of electronic, missile, and aerospace components. Temperature range is from −100°F to 500°F with an accuracy of control of ±0.5°F. Temperature is controlled by means of an electronic unit with resistance bulb sensor which "anticipates" on a proportioning basis the actual set-point, either high- or low-side, and effects minimum variation in temperature over the full range.

Circle No. 236 on Subscriber Service Card

Horizontal-Drilling Unit

A horizontal drilling and master spacer unit for rotary positioning work with great precision is available from Erickson Tool Co. The rugged multi-index spacer is teamed with a drilling device which can be set to Jo-block accuracy. The unit guarantees repeat indexing within low tenths—radial accuracy of 0.001 in. cumulative error on



a 6-in.-diameter circle. Location of holes being machined in relation to the part can be held to ±0.0005 in. or closer. The unit can be set up with a planer gage, micrometer, or gage blocks.

Circle No. 237 on Subscriber Service Card

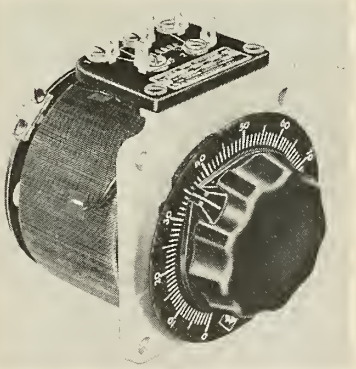
Ball Couplings

A new concept in ball-type self-sealing quick-disconnect couplings, providing "Boresite" smoothness throughout the entire flow passage, has been developed by General Pneumatics Corp. Exactly 90° rotation of the balls is accomplished by twisting the cover approximately one quarter turn, without resorting to gearing or cams. The use of rubber seals throughout the assembly provides zero external leakage in either the coupled or uncoupled conditions, even when the medium is a gas. The locking device is visible from all angles and, because it is an integral part of the rotating mechanism, is extremely rugged and positive.

Circle No. 238 on Subscriber Service Card

Variable Transformers

A compact 50/60 cycle Powerstat variable transformer series introduced by Superior Electric Co. has output ratings up to 3.75 amp with constant current loads and up to 5.5 amp with constant impedance loads. Called the 21

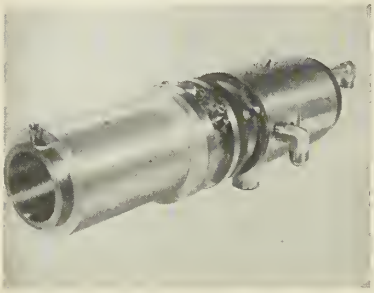


Series, the Powerstats include: gold alloy-plated commutator; functionally designed terminal arrangement for connection flexibility; terminal adapters for either soldered connections or push-on connectors; adjustable ⅜-in. solid metal shaft; square base design for increased strength and reduced overall height and space behind panel.

Circle No. 239 on Subscriber Service Card

Plasma Modular Mixers

Two modular mixing attachments for a 300KW arc plasma generator have been introduced by Plasmadyne Corp. The subsonic and supersonic mixing modules are used to create environments for re-entry testing of materials, heat transfer and gas dynamic evaluations



of high-temperature gases and plasmas and for chemical synthesis investigations, magnetohydrodynamics studies and plasma jet thrust investigations. The attachments are available in two configurations.

The AM-4 is designed to operate into ambient pressures between 0.5 and 2.0 atmospheres (abs.) and provides a subsonic plasma stream. The second unit, the AM-5 assembly, operates into a vacuum nominally 1/17th that of the associated M-4 mixing chamber and provides a supersonic flow, nominally Mach 2.5 in air.

Circle No. 240 on Subscriber Service Card

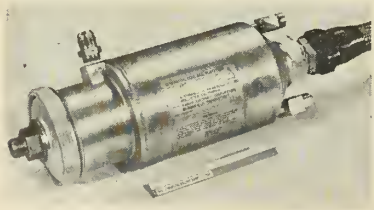
Floating Locknuts

The Delron Co. has avalable a complete line of structural floating locknuts for honeycomb- or sandwich-type panels. The Delron 700 series combines a floating nut element with a structural type panel fastener. The floating action of the fastener allows for total misalignment of 1/16 in. One straight-drilled thru-hole prepares the panel for fastener installation. Hand arbor press or any ram-type equipment can be used to expand the fastener within the core area, making it possible to distribute loads to both cover sheets.

Circle No. 241 on Subscriber Service Card

Cool Gas Generator

A cool gas generator with significant advantages over prior systems for the inflation of lightweight rubber/fabric bags is available from McCormick Selph Associates. The generator incorporates an electrical initiator, a solid propellant for gas generation and pressurization, and a coolant for temperature control. During operation, the hot gas from the burning propellant is mixed with the coolant within the gas generator. Upon mixing, vaporization of the coolant reduces the temperature of the hot propellant gas to a predetermined value, depending upon the ratio of hot gas to the coolant.



Circle No. 242 on Subscriber Service Card

Scope Display Test

A transistor test instrument that provides an oscilloscope display of beta (grounded emitter current gain) as a function of collector current has been developed by Orbitec Corp. Orbitec Model T3A-2 is capable of showing a complete plot of beta vs Ic from 0 to 500 ma peak current at fixed frequencies of 1 kc and 10 kc. Provision is also made for obtaining such plots out to 1 mc by means of an external generator.

The instrument provides a convenient method for checking the beta characteristics of transistors for use in linear or non-linear circuits where beta values



are important parameters of design. In addition, the instrument will be of value to transistor manufacturers who are seeking ways to improve production methods of selected transistors.

Circle No. 243 on Subscriber Service Card

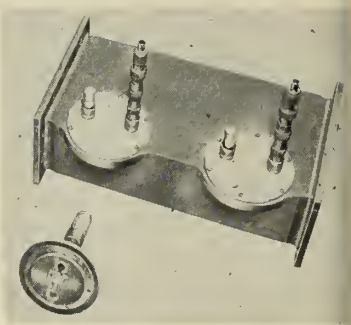
Mobile Computer

Clary Corp. is marketing a mobile DE-60 M computer. The four-wheeled unit consists of Clary's direct-entry transistorized DE-60, contained in a walnut cabinet, with input and output units recessed in top surface wells. The programing unit is located at the front and the arithmetic center is accessible from the rear. The unit is available with typewriter, punched tape or line printer output.

Circle No. 244 on Subscriber Service Card

Resistive Loop Coupler

A family of bi-directional resistive loop couplers is being marketed by FXR, a division of Amphenol-Borg Electronics Corp. These couplers feature high directivity and coupling attenuation in minimum space. The total length of the L band model, including the necessary WR-650 waveguide mounting section, is only 15 in. In-



tended primarily for power and VSW monitoring, the S61-2 has been use in waveguides pressurized to 30 lbs carrying 15 Kw average and 10 Meg watts peak power.

Circle No. 245 on Subscriber Service Card

Vacuum Block Valves

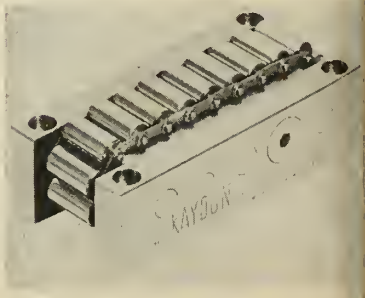
A series of block valves for moun ing in various types of industrial high vacuum systems, available from NR Equipment Corp., have a commo bellows seal assembly for sizes less tha 1 in., are factory leak-tested and pr vide for maximum gas flow within con pact design. Machined from solid-bra square stock, the porosity-free valv are available with in-line or angle co figurations for soldered or screwed co nections in sizes from ¼ to 1½ in.

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—reviews—

ROGRESS IN AERONAUTICAL SCIENCES, Vol. edited by Antonio Ferri, D. Kuchemonn, and H. G. Sterne, Pergomon Press Inc., New ork, 280 pp., $12.

The theory of the current series of hich this is the first volume is to publish n annual text of specially commissioned apers in the aeronautical sciences which will provide the specialist reader with an rderly but concise survey of recent ork. . . ." This is an admirable project ut necessarily falls far short of its goal— for no other reason than space consid- rations.

The field is somewhat limited by the dmitted exclusion of papers on propulsion nd combustion, and the articles presented annot touch much of the major work be- ng done in aeronautics. Nevertheless, the even papers included are well presented nd cover modern lines of research such as hemical reactions in boundary layers, ypersonic ablation, and the dynamics of n ionized gas.

ASICS OF ANALOG COMPUTERS, T. T. Truitt nd A. E. Rogers, John F. Rider Inc., New ork, 400 pp., $12.50.

An almost pictorial presentation, this ook utilizes more than 400 diagrams and xt in a quick and easy-to-understand in- roduction to analog computer theory. This ublishing technique, typical of Rider, has roved quite successful, particularly in a ompanion volume—"Basics of Digital omputers."

The analog text is not recommended for omputer engineers and scientists. It should e illuminating, however, to technicians in he field and to non-computer engineers nterested in some light technical reading.

It is divided into three volumes—the rst concerned with analog computing prin- iples, the second with general-purpose nalog computers, and the third with use f the d-c analog computer.

PACE ASTROPHYSICS, edited by William Lil- r, McGrow-Hill Book Co., Inc., New York, 72 pp., $10.

Dedicated entirely to astronomical and strophysical problems investigated from bove the atmosphere, this book compiles he lectures given during the 1959-60 cademic year at the University of Michi- an's department of astronomy.

The contributors include many of the orld's better-known workers in astro- hysics. They give detailed descriptions of he astronomical experiments made with rtificial satellites and space probes, and elate the theoretical investigations behind ome of these experiments.

The book features much previously un- ublished material and is a worthwhile ddition to the library of any student of strophysics.

—when and where—

JULY

Planning Aspects of Atomic Shelter, Seminar, Pennsylvania State University, University Park, July 9-12.

4th International Conference on Medical Electronics Combined with 14th Annual Conference on Electric Techniques in Medicine & Biology, Waldorf-Astoria, New York City, July 16-21.

Western Plant Maintenance and Engineering Show, Pan Pacific Auditorium, Los Angeles, July 18-20.

Structural Engineering Aspects of Atomic Shelter, Seminar, Pennsylvania State University, July 23-Aug. 4.

AFOSR, Differential Equations in Nonlinear Mechanics, Cosponsored with Martin's RIAS, Air Force Academy, Colorado Springs, July 31-Aug. 4.

Physics of the Solar System and Reentry Dynamics, National Science Foundation, NASA, Virginia Polytechnic Institute, Blacksburg, Va., July 31-Aug. 11.

AUGUST

Space Age Astronomy, sponsored by Douglas Aircraft Co., CalTech, Pasadena, Aug. 7-9.

American Rocket Society/Stanford University Guidance and Control Conference, Stanford University, Calif. (Some sessions classified), Aug. 7-9.

Society of Photographic Instrumentation Engineers, 6th Annual Technical Symposium, Ambassador Hotel, Los Angeles, Aug. 7-11.

Survival in the Nuclear Age-Executive Management Seminar, Pennsylvania State University, Aug. 13-18.

International Astronomical Union, 11th General Assembly, Pasadena, Calif., Aug. 15-24.

American Rocket Society International Conference on Hypersonics, Massachusetts Institute of Technology, Aug. 16-18.

National Naval Aviation Meeting, Institute of the Aerospace Sciences, San Diego, Calif., Aug. 19-24.

Welded Electronic Packaging Association Symposium, Lockheed Missiles and Space Division's Palo Alto Research Facility, Aug. 21.

National Academy of Sciences 10th Pacific Science Congress, University of Hawaii, Honolulu, Aug. 21-Sept. 8.

Western Electronics Show and Convention (WESCON), Cow Palace, San Francisco, Aug. 22-25.

American Rocket Society, 4th Biennial Gas Dynamics Symposium, cosponsored with Northwestern University, Technological Institute, Evanston, Ill., Aug. 23-25.

American Institute of Electrical Engineers, Pacific General Meeting, Salt Lake City, Aug. 23-25.

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editorial . . .

The Moment of Truth Is Here

A GREAT DEBATE is under way among the nation's defense experts in Congress, the military services and the Administration concerning the future of our missile and space programs. It has been gaining headway for the last several months, and the President's call for additional spending of $7-9 billion on space over the next five years has added impetus to it.

Like an iceberg, only a small fraction of this debate shows above the surface. But the portion which appears in the form of public statements and Congressional testimony is sufficient to indicate the depths to which it reaches.

This debate is to be expected in the early days of a new Administration and, if not permitted to continue too long, is a healthy thing. But it is apparent that the time has come to end the debate, make some clear policy decisions and begin developing the teamwork necessary to put this nation ahead of the Soviet Union in missile/space activities. Further infighting will only develop tensions which can slow the entire effort.

Let's take a look at some aspects of the debate, as they show on the public record—those portions of the iceberg above the surface, as it were. The aircraft vs. missile wrangle, once quiescent, is raging again:

May 3—"After all, the missile can do only one of two things; it can go or it cannot go. A bomber, on the other hand, has an almost infinite variety of capabilities."—Chairman Carl Vinson (D-Ga.), House Armed Services Committee.

May 12—"It has not been demonstrated that an intercontinental ballistic missile with a nuclear warhead will actually work."—Senate Armed Services Committee report.

May 26—Secretary of Defense McNamara stated that if Congress provided funds for additional manned bombers, he would recommend against spending the money.

June 28—The House provided $448 million in new obligational authority for long-range bombers.

July 2—Outgoing Air Force Chief of Staff Thomas White stressed the continuing importance of manned bombers before a nationwide TV audience, noting that the Russians have been flying what appears to be a new long-range bomber over Moscow in preparation for the Tushino air show.

We can remember when the Russians feinted us on this one before. Accepting phony intelligence of a rapid Soviet bomber buildup, we poured money into manned aircraft programs only to discover that the Russians actually had been putting their strongest efforts into missile development. We were far behind and today there is a well-publicized Missile Gap. Or is it that the Soviets now feel they must close the Bomber Gap? The Administration must decide.

We can find further evidence of the great debate in the *Dyna-Soar* program:

March 1—Gen. Schriever made it clear he would like a $100-million increase in Fiscal 1962 funding for *Dyna-Soar*—to bring the total to $170 million.

June 21—Assistant Secretary of Defense John Rubel expressed doubts that additional funding would substantially speed up the program and added: "*Dyna-Soar* is expanding at about the right rate."

June 26—Secretary McNamara questioned whether additional *Dyna-Soar* money could be used either effectively or efficiently.

June 28—In an effort to prod the Administration into a three-year speed-up, the House voted an additional $85 million for *Dyna-Soar* above the $106 million already in the Fiscal 1962 budget.

We might point out that, while not an accepted member of the debating teams, Yuri Gagarin told a press conference in Helsinki on July 3 that the next Soviet space flight will be more serious and informative than any U.S. space project.

THE DEBATE CONTINUES also over the need for U.S. military space programs:

June 21—Assistant Defense Secretary Rubel stated that the next decade will see only a modest use of space for military purposes, consisting largely of support functions such as *Samos, Midas* and the communications satellites. He added: "I doubt if there will be a military base on the moon (within the next 25 years). It may be more important in the next few months to have a few men in Laos than to have them in orbit."

June 27—"Earth can be dominated from space. . . . The lesson is clear that a vehicle in orbit which can launch a missile up and away toward Venus is not limited as to aiming points on the earth close below. We are determined not to be disfranchised in space, and we are determined that no nation shall be disfranchised on earth by a threat from space."—Air Force Secretary Zuckert.

June 28—Dr. H. Guyford Stever, chairman of NASA's research advisory committee, said putting a man on the moon is a military necessity for the U.S. Unless the Air Force wins a major role in the moon program, he said, "it stands to lose headway in development of future military space capabilities."

And so the debate continues. But it is now a time for decisions. The late Ernest Hemingway put into the common language a phrase well known to aficionados: the moment of truth.

For the Kennedy Administration, in this field, it is here.

William J. Coughlin

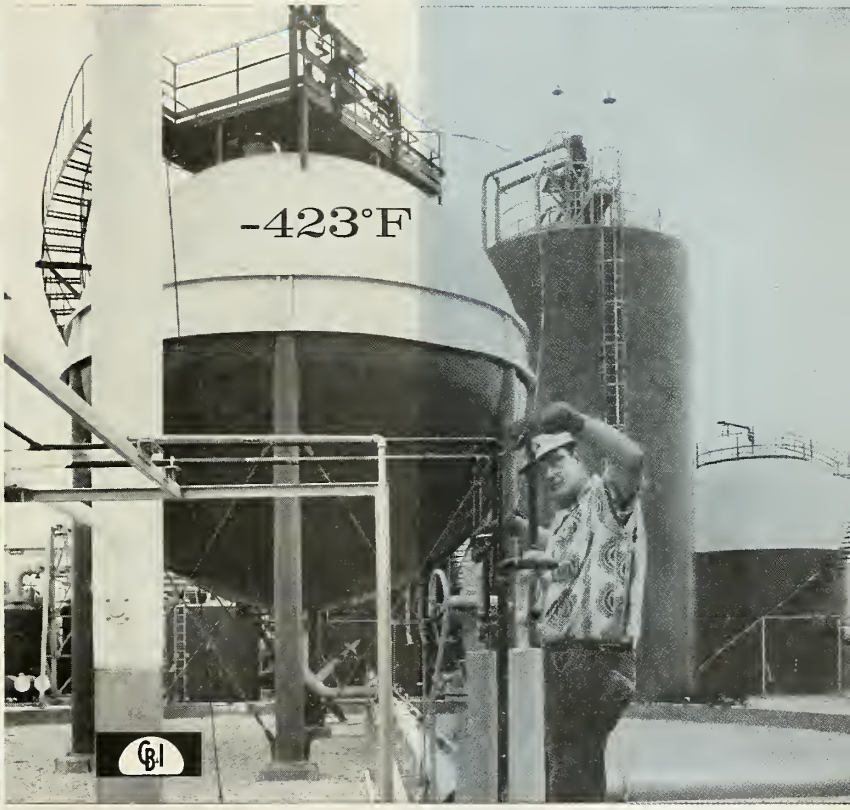
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ABOVE: Aluminum inner shells and carbon steel outer shells were used for the two cryogenic tanks. The spherical tank is 28 ft. in diameter and the cylindrical tank 21½ ft. Special insulation is between the shells.

TOP LEFT: The inner sphere is suspended in the outer sphere by stainless steel rods positioned around the perimeter. Resting on the ground nearby is the aluminum inner shell of the cylindrical nitrogen tank.

LEFT: A trailer is being loaded with liquid hydrogen for delivery to missile centers, other government installations, or industry.

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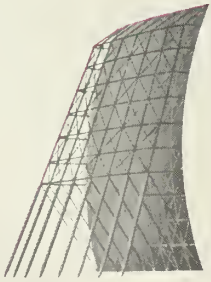
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THE MISSILE/SPACE WEEKLY

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HITCO-developed ablative materials and fabrication techniques are also providing Atlas and Titan nose cone heat shields. These materials enabled the first ICBM nose cone recovery.



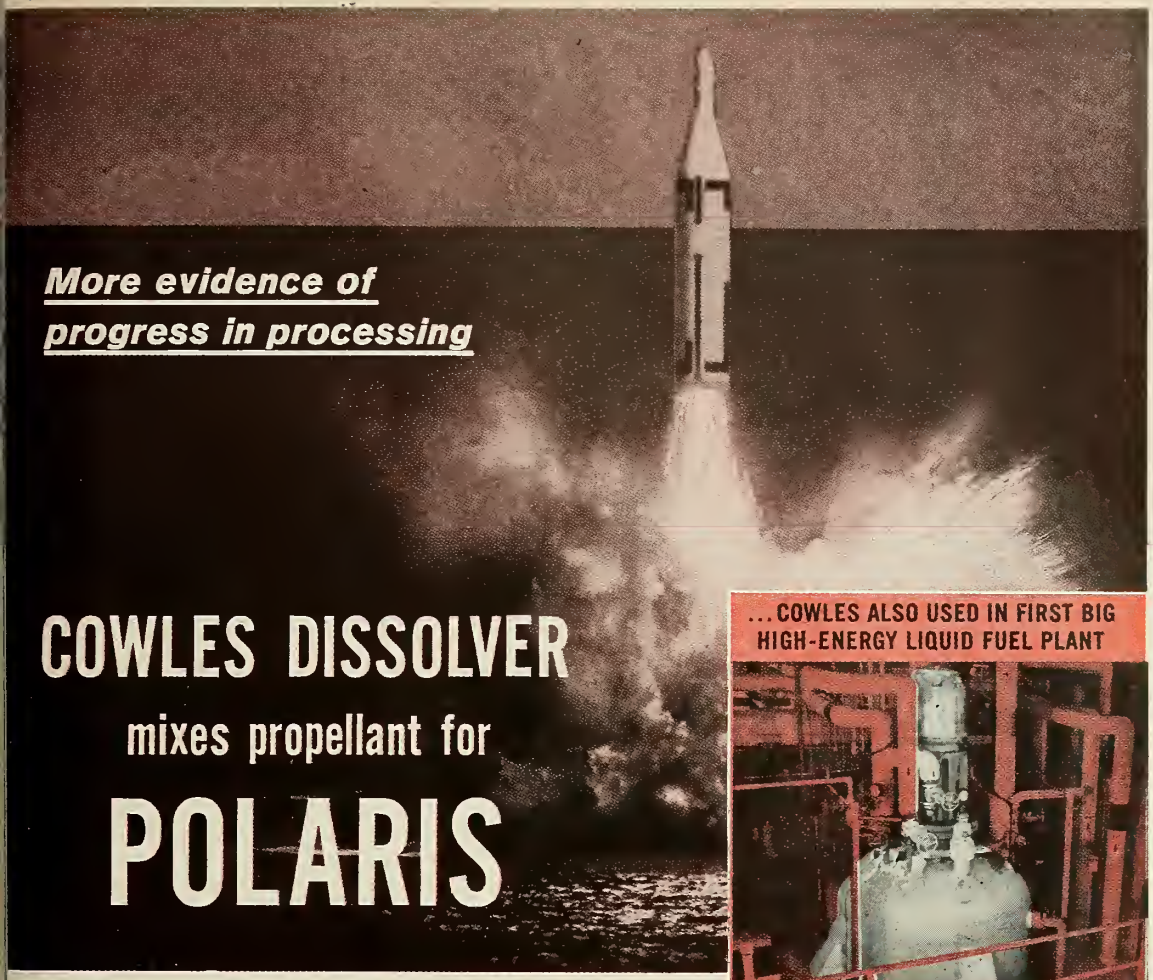
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missiles and rockets

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THE COVER

A milestone in U.S. missilery was successful first launch Feb. 1 of Air Force's Boeing Minuteman ICBM. M/R's Fifth Annual Missile/Space Encyclopedia starts on p. 16.



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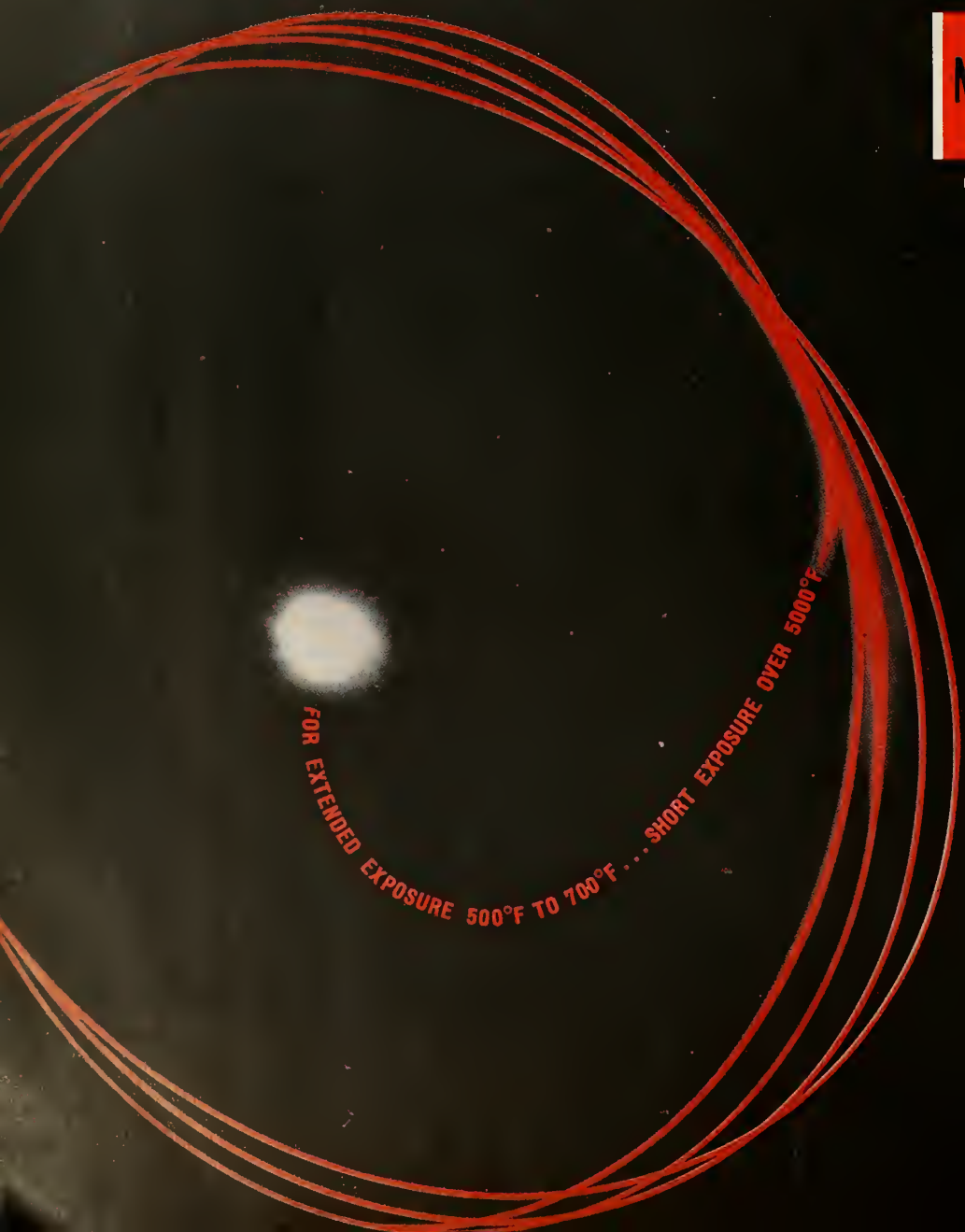
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NEW M/R EDITORS, Hal Taylor (left) and Tim Trainor, hold forth at staff meeting.

memo from the publisher

IT IS ALWAYS a pleasure to receive a letter from a missile/space firm complimenting us on the competence and technical knowledge of a MISSILE AND ROCKETS editor who has visited the plant. We often are asked where we find these editors and what their background is. By telling you about the two gentlemen pictured above, both of whom have joined the M/R editorial staff in the past month, we may be able to answer those questions.

Hal Taylor, left, joins us from the Washington bureau of the Journal of Commerce, where he covered foreign trade and investment, international finance, and a number of government departments, including State and Interior. For a year, he was the Journal's Supreme Court correspondent. Hal is that most valuable of men—a good reporter.

He combines it with a knowledge of the industry. During two years in the Army, his principal assignment was in supply work for *Nike* sites in the Washington, D.C., and Maryland areas.

Before his Army stint, Hal briefly attended Johns Hopkins University. He obtained his bachelor of science degree from the University of Maryland in 1959. His hometown is Blakely, Pa. Hal's knowledge of government agencies is being put to good use. We've assigned him to NASA, replacing Jay Holmes, who has resigned.

Jim Trainor, right, comes to us after more than three years on U.S. Army missile programs. After graduation from West Point, he spent two years with the 209th Artillery Group *(Redstone)* at Ft. Sill, Okla. There, he participated in the planning, testing and launch operations of seven *Redstone* firings, including both Engineer-User tests and Annual Service Practice Firings.

Trainor was transferred in 1960 to Redstone Arsenal, where he worked in the program coordination office for the *Pershing* missile system. He later served as chief of the Combat Requirements Branch in the Advanced Plans Division of ABMA, translating the Army's future missile requirements into specific weapon system plans.

Like Taylor, Trainer also has a good background in journalism. Before his appointment to West Point, he put in five years on the Detroit Free Press, first as a copyboy and later as a rewrite man. While at Redstone Arsenal, he worked part-time on the Huntsville, Ala., Times. Jim replaces Hal Gettings, who has left us to join Dynatronics, Inc., as advertising and public relations manager in Orlando, Fla.

•

WHILE WE ARE on the subject of staff members, we know her friends will be pleased to hear that our very capable Space Medicine Editor, Heather David, has just produced a Little David satellite, female-type, orbital weight seven pounds, 13 ounces, launch site: Sibley Memorial Hospital, Washington, D.C. To add to her husband's nervousness, Heather insisted on working right up to the start of countdown and actually had a hand in the preparation of this week's issue.

•

IT IS to hard-working people such as these that we are indebted for the coverage which has pushed MISSILES AND ROCKETS paid circulation above the 33,000 mark for the first time, effective with this issue. That's a gain of almost 3000 in the past six months.

In addition to those 33,000 subscribers, this annual special issue of M/R will go by request to another 7500 members of the military establishment and the National Aeronautics and Space Administration. ⁂

Edward Kolcum



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Santa Barbara, California



letters

Thanks Are Ours

To the Editor:

Thank you for reprinting my memorandum on Columbus ("New Route to Cathay—Step by Step," M/R, May 29, p. 37), which several people felt was fitting of wider distribution than internal laboratory.

There was one misprint (my fault) in the original which may arouse historians or Englishmen among the readers; that is, Henry III should read Henry VII. Our statement would be equivalent to crediting McKinley with the Louisiana Purchase.

Ralph S. Cooper
Los Alamos Scientific Laboratory
University of California
Los Alamos, N.M.

French Propellant

To the Editor:

Your issue of June 5 includes an article on French and British progress in the field of rockets. In this article, under the subtitle "French potpourri" you reported that certain firms associated in the SEREB program complained that their own progress was impeded by the Service Industriel des Poudres (Industrial Propellant Division), which is responsible for furnishing solid propellant grain.

We are astonished that a magazine with the prestige of your publication would publish without verification any information which might tarnish the name of the highly reputable Service Français des Poudres (French Propellant Agency). We believe that the writer of this article was taken advantage of by an irresponsible news source whose particularly flighty opinion was manifestly unsupported by any facts.

As a rule we do not comment on passing press reports, but because we are a MISSILES AND ROCKETS subscriber we feel obliged to point out the surreptitious character of this information, especially incompatible with the spirit of your magazine, usually so painstakingly accurate.

L'Ingénieur Général Militaire
Tavernier
Directeur des Poudres
Paris

The report published in M/R came from several highly placed sources in French industry.—Ed.

Tough Skating

To the Editor:

Mr. Rabinow's report in M/R, June 12, attempts to discredit Mr. (Norman) Dean's complicated demonstration of rotary-to-linear thrust without counter-thrust.

However, in the very last paragraph (on p. 42) doesn't Rabinow incorrectly say, in effect, that you can't move on roller skates by "body English"? You don't absolutely need friction between yourself and the floor to get some forward motion, although friction helps of course in many "leap-frogging" actions. Further, wouldn't the cited load be moved the stated distance from the Dean model's plumb line, if attached to the suspended platform (i.e., "fixed frame")?

Will you or Mr. Rabinow comment on the above error in the subject analysis?

H. Dudley Kellogg
(Member Franklin Institute)
Narberth, Pa.

A risky but instructive experiment would be to try using body English as a propelling force while standing on roller skates on ice.

Yes, the load does move—which is the basis of the Dean patent—but not without reaction exterior to the system.—Ed.

Saturn by Blimp?

To the Editor:

I am writing about the letter, "Saturn by Dirigible," from C. W. Farrar (M/R, July 10, p. 7). Mr. Ferrar proposes to move the *Saturn* booster to Cape Canaveral by an all-metal airship, but Maj. Gen. Don R. Ostrander (NASA Director, Launch Vehicle Programs) claims that total costs, both developmental and operational, would be too high.

Time magazine of July 7 states that the U.S. Navy blimp program is to be suspended, and that by next December all but two of the blimps will be stored.

Could not these blimps be used for the transportation of the *Saturn* booster? This would eliminate the development cost of the all-metal airship.

David W. Johnston
Washington, D.C.

A larger dirigible would be required to lift the relatively large Saturn stages.—Ed.

Mud for Moon Shelters

To the Editor:

Present space travel concepts are based upon the idea of taking all the material needed on a moon trip and returning to the earth. But, in view of the enormous cost of the Kennedy moon program, such concepts are in need of reappraisal.

A saving of one pound at the lunar end of the flight will mean a saving of at least 10,000 lbs. at the earth end, even with improved rocket performances, while elimination of the return trip will raise this to at least 30,000 lbs.

If half the other operations in the Kennedy program are reduced in the same proportion as the actual moon voyage, elimination of the return trip alone will



One of the many promising studies now being conducted by Lockheed/Georgia scientists involves injecting a hypergolic agent into a fuel tank—and using the gas resulting from the combustion to pressurize storable propellants. This program, under U. S. Air Force contract, is typical of the many advanced aerospace research activities currently in progress at the Georgia Division.

LOCKHEED/GEORGIA
Marietta, Georgia

duce a $40,000,000,000 project to $13,-7,000,000 plus.

This fact underlies the importance of imitive survival techniques to enable one live on the moon with a minimum of uipment from the earth.

Shelter, by far the heaviest item, merits ecial discussion. Excavation machinery ll be out of the question for one wanting really "go light." Natural caves cannot depended upon, and will still have to be ndered air-tight. Above-ground shelters ll therefore be a "must."

Transporting the shelter from the earth ight involve as large a weight penalty as return trip; bringing up commercial ce-nts to bond lunar material together ould again involve costly weight pen-ties.

Zwicky's proposal for welding rocks gether would require costly equipment r producing high temperatures in quan-y, as well as a serious cracking problem. it cementing with frozen mud would pear perfectly practicable under lunar ade conditions, for which the polar re-ons will be especially favorable.

Drying should be superficial at tem-ratures where the free path of the water-por molecules will be larger than the re space. The mud can be sprayed from gun, like stucco, and will freeze almost stantly at such temperatures.

Meteor and radiation protection will be ovided automatically. And fossil ice or sorbed gases for water and oxygen pro-action should be especially abundant at e lunar poles.

Theodore B. Dufur
Los Angeles

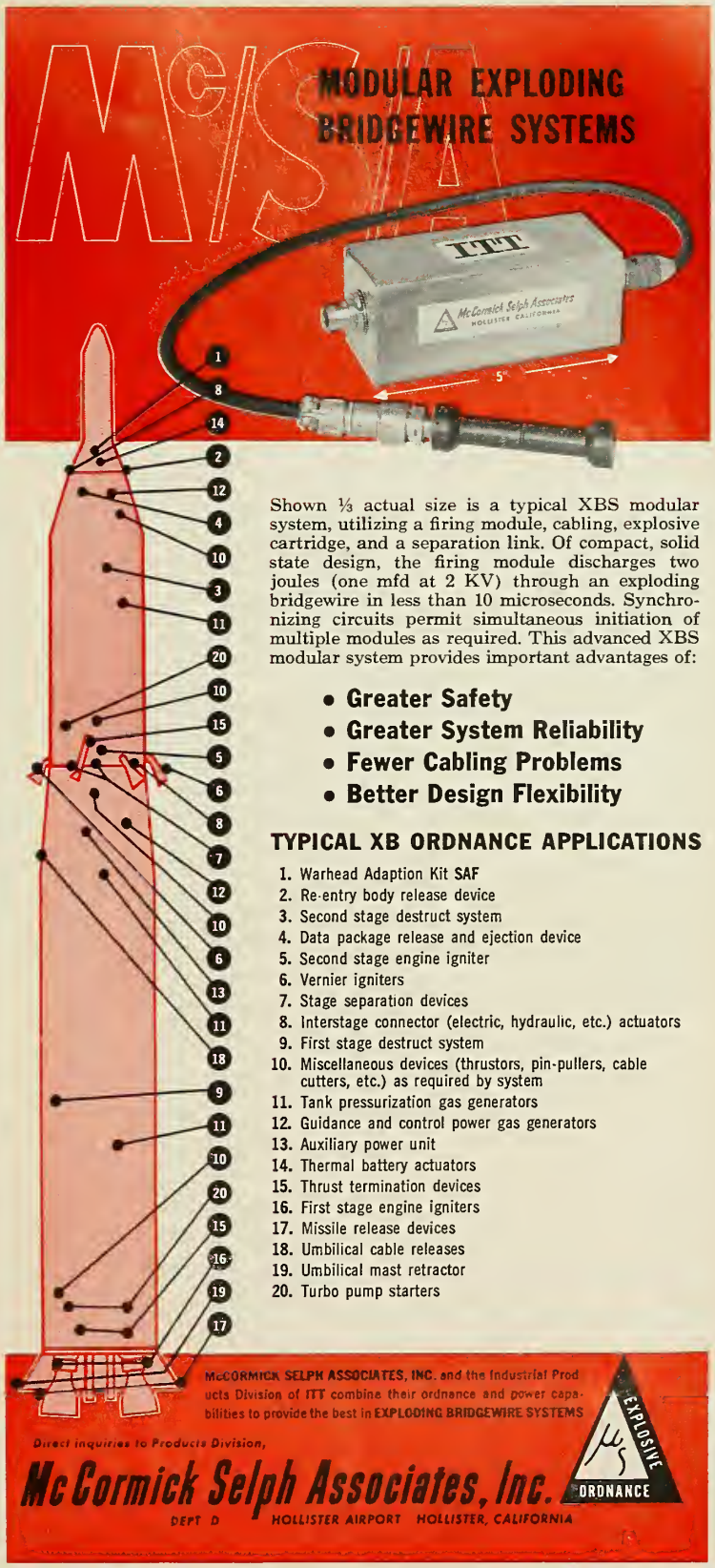
FO's Will Rise Again

the Editor:

I somehow missed until recently your intillating reply to my questions on the SAF saucer snow job. Might I ask if you e *really* interested in curtailing data sup-ression and falsification of information or e you just pretending when you edito-alize about the evils of censorship and overnmental deceit? . . .

George W. Earley
Bloomfield, Conn.

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The Countdown

WASHINGTON

Missiles and Berlin

Military experts say the Administration is much too late in trying to strengthen conventional forces to cope with a Russian move on Berlin. They say only nuclear bombs and missiles will deter the huge Red Army and that faster deployment of such weapons as *Davy Crockett* would do far more to maintain the peace than a couple of reserve divisions.

Looking for T-3's

Administration officials continue to leak the comforting report that the Missile Gap is growing narrower and narrower. The interesting proof: U-2-less intelligence has not been able to locate positively any large number of sites. Ergo, if you can't find the enemy, he must have gone away.

SS-11 Wins Army Airborne Role

The Army has firmly decided to deploy the Nord *SS-11* as an airborne and vehicle-carried antitank missile. An agreement has been signed with Nord to manufacture *SS-11's* in the United States. The Army previously designated Nord's *Entac* its hand-carried antitank missile.

Operational Titan Slips

The first operational *Titan I's* at Lowry AFB are now expected to be ready for emergency use if necessary later this year, but the base is not expected to be declared operational until early 1962. Originally, the first squadron at Lowry—first in the *Titan* ICBM force—was scheduled to be operational this summer.

Space Bill Agreement Seen

Members of the Senate and House Space Committees are expected to reach agreement within the next week on the revised $1.7-billion NASA authorization bill. The House already has passed the earlier $1.3-billion version but is expected to go along with the Administration-sought Senate bill. Floor action is expected to follow quickly after the conference committee meets.

Moscow Said "Thanks"

Friendly scientists at NASA sent the Russians some space-snapped pictures of cloud cover over the Soviet Union. NASA also asked the Russians to supply information about weather conditions in the Soviet Union, as observed from the ground, to compare notes. The Russians replied they don't want to play that game. But they said thanks for the pictures, anyway.

INDUSTRY

F-1 Firings Begin

First static firings of the Rocketdyne F-1 engine, now under way, will gradually build up to the rated top thrust of 1.5 million lbs. Tests should shed some light on problems of propellant feed systems for liquid boosters of over 20 million lbs. total thrust. Engineers feel pump-fed and pressure-fed techniques have major disadvantages and they may have to shift to a delta-P or gravity-head system.

R&D Intelligence

NASA feels low wattage yield of nuclear power sources makes them unsuitable for both *Tiros* and follow-on *Nimbus* weather satellites . . . AMC has put out a request-for-proposal to fabricate an electro-formed part which will withstand 3500°F for at least 100 hours. Component reportedly is for leading edge of a wing . . . Nine different methods of thrust vector control are under study by Aerojet-General for large solid-rocket boosters. Most promising: liquid injection to create a shock wave which will divert exhaust stream.

Air-snatch for Drones

Air Force is considering air-snatch recovery of target drones based on the *Discoverer* system. One system is being tried out on a Kaman helicopter at Holloman AFB. Potential savings in preventing saltwater landings: $5 million in reduced maintenance.

Minuteman Dividend

The Air Force says experience gained in *Minuteman* has saved about 20% in the estimated development cost of the Douglas *Skybolt* propellant, a polyurethane with aluminum additive. The two-stage ALBM has an optional coast phase which can be utilized between stages for range adjustments and a gimballed second-stage nozzle for precise thrust vector control.

Fast Switch

Crew of four Dynatronics engineers cut a gear box out of an antenna at Eglin AFB and flew it to San Nicolas Island off Point Mugu, Calif., to fix a *Tiros* antenna that went out July 4. The fast switch—under difficult field conditions—enabled NASA's *Tiros* shot to go July 12 with only one day's delay.

INTERNATIONAL

Sweden Buys Bloodhounds

The Royal Swedish Air Force has awarded a multi-million-pound order to British Aircraft Corp. for *Bloodhound Mark II* surface-to-air missiles. The order is said to be the largest ever placed by a foreign government for British missiles. No specific amount has been disclosed. Meantime, British Aircraft is reported to be preparing to announce another large order within the month.

Aussies Developing ASW Missile

The Australian Department of Supply has under development an ASW booster for the Mark 44 torpedo. The missile is said to have twice the range of *Asroc*, which also carries the Mark 44. The U.S. has contributed $4 million to the program.

Vigilant Struts Its Stuff

High-ranking officers from France, Britain, the United States and Yugoslavia watched the first demonstration of the Vickers *Vigilant* antitank missile in England earlier this month. Score against four moving Centurion tanks: 12 hits, one miss.

First Midas Scans USSR

The Air Force launched a 3500-lb. *Midas* IR early warning satellite into a circular 1850-mi.-high orbit July 12 with an *Atlas-Agena B* from Point Arguello, Calif.

Midas III's 160-min. orbit is taking it over Russia as well as every other point on earth in a test of its detection payload. Presumably it will be tested against U.S. missiles launched at the Cape and Vandenberg AFB. Tracking and readout stations are at Vandenberg, Kaena Point, Hawaii, and New Boston, N.H., with systems control at Sunnyvale, Calif.

In two previous shots from the Cape last year, the first failed to orbit and the radio transmitter of the second failed shortly after it went into orbit.

Tiros Hunts Hurricanes

A *Tiros III* meteorological satellite was launched successfully July 12 by NASA, with both the *Thor Delta* booster and satellite equipment functioning perfectly.

NASA officials said that the satellite's orbit—designed to gain new information on hurricanes—has an apogee of 450 miles, a perigee of 425 miles and an inclination of 48 degrees, 100 minutes.

The satellite differs from its two predecessors, *Tiros I* and *II*, in that it carries two wide-angle television cameras and a new infrared radiation experimeent.

A new tracking station at Santiago, Chile, is also being used for the first time in the *Tiros* Program.

The satellite transmitted good pictures of cloud cover on its first pass over the earth.



Swedish Order Bloodhound

BRITISH BLOODHOUND Mark 2, shown at operational site, has been ordered for Swedish air defense in "large" contract.

AF Overhauls Staff

The Air Force has announced a major reorganization of the Air Staff, effective July 1.

The new posts:

Deputy Chief of Staff (Systems and Logistics)—a combination of staff responsibilities for development, procurement and logistic support of aircraft, missiles, space and electronic systems. To be under Lt. Gen. Mark E. Bradley.

Deputy Chief of Staff (Research and Technology)—Assigned to Lt Gen. Roscoe C. Wilson, will combine staff action on research, advance technology, studies requirements and development planning.

Other assignments:

Brig. Gen. Milton B. Adams—supervise development, procurement production and review all systems programs at staff levels.

Maj. Gen. William T. Thurman—Director of procurement management, responsible for major policy and procedure in field procurement agencies.

Brig. Gen. M. C. Smith—Director of systems services for the S&L Office. Responsibilities include: missile range and special group environment support; standardization and engineering; tech and industrial reports and general equipment support.

System staff offices (SYSTO's) will be set up for systems such as *Minuteman* and B-70, and will report directly to Asst. DCS/Systems. Units will exist only during the critical phase in the system's life cycle.


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DCS/R&T will be the AF focal int for scientific and tech interion with agencies such as AEC d NASA.

enwein to Lead AIA

August Esenwein has been elected esident of the Aerospace Industries ssociation, replacing Gen. Orval ook, who will resign in December. enwein, retired Convair Executive ce President, will assume the title Deputy General Manager of AIA Oct. 1, pending his succession to e presidency.

MR Communications Growing

A 700-mile extension of the Atntic Missile Range underwater comunications net will be built by the am of U.S. Underseas Cable Corp., elps Dodge and Northrop, with SUCC overall manager. When fined, the $5-million Air Force Mise Test Center project will be capae of providing 60 4-kc channels in o directions. Work is scheduled to completed in 26 months.

nother Discoverer Snatched

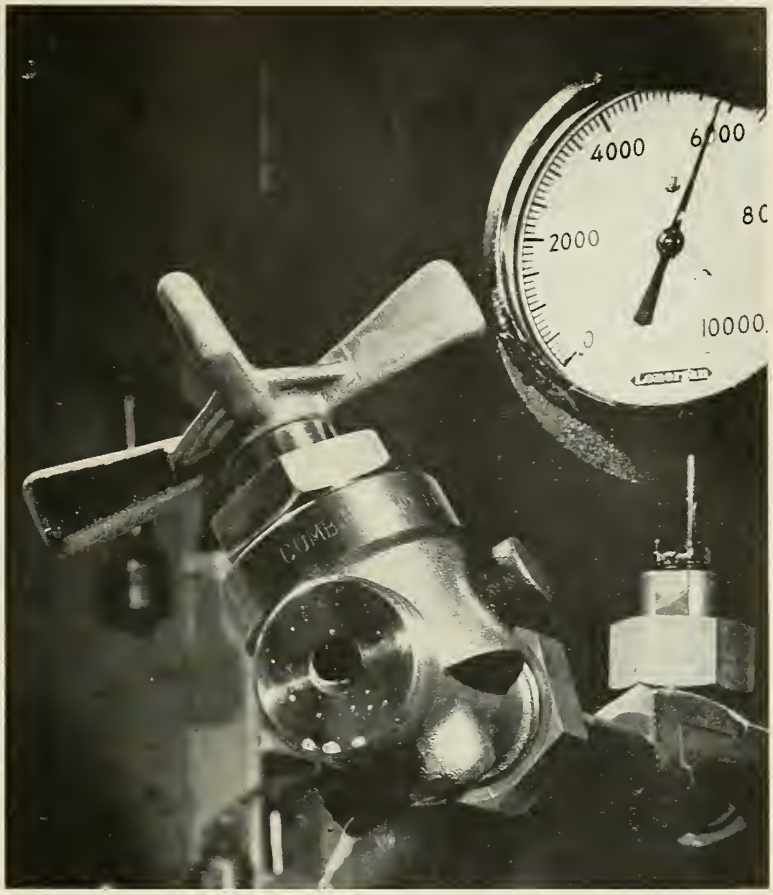
Fourteen minutes after first sightg, the *Discoverer XXVI* capsule as safely air-snared north of Hawaii ly 9 by a C-119 Flying Boxcar. he fourth successful air recovery in e series came after 32 orbits, some) hours and 36 minutes after launch om Vandenberg AFB.

Originally it was hoped to leave e capsule in orbit four days. "Techcal reasons" forced scientists to igger the return mechanism early.

The capsule carried samples of licon, iron, bismuth, yttrium, magsium, nickel, lead and uranium. he silicon samples may provide inrmation on damaging effects of diation on solar cells. After recovy, *Discoverer XXVI* was flown to nnyvale, Calif., for study and evalation.

ew Bullpups Upcoming

A $2.25-million AF contract was varded The Martin Co. for initial oduction of the nuclear-tipped *Bullp* GAM 83-B. The air-to-surface eapon has "offset launch" ability, hich permit the pilot to guide it wards targets lying at extreme gles from line of launch.



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Atlas Succeeds, Sets Mark

The trouble-plagued *Atlas-E* whizzed to a new distance record for military flights—9050 miles. The Canaveral-Indian Ocean trip on July 7 beat by 10 miles two earlier *Atlas* flights, and was the first long-range success for the *E*, which had failed in 7 of its 10 previous launchings.

After the flight, a General Dynamics spokesman said he hoped the shot marked the end of the missile's problems.

The Air Force hopes to have the bird operational late this year.

Rover's Clogged Plumbing

Some 100 plumbers and pipefitters walked off the job June 30 at the Project *Rover* test site northwest of Las Vegas.

AEC officials claim the walk-out will delay testing of the nuclear rocket program. Union leaders say their members want 5 cents an hour more than management's proposal of a 45-cent hourly raise, spread over a two-year period.

Spectre of Red N-Bomb

Russia may have beaten the U.S. in developing a neutron bomb and may use it in a Berlin showdown, Sen. Thomas Dodd (D-Conn.) warned in U.S. News & World Report. Said Dodd: "If they (the Russians) have violated the 2½-year honor moratorium on testing—and to my mind they would not be communists if they had not cheated on it—then they already may have beaten us to the neutron bomb."

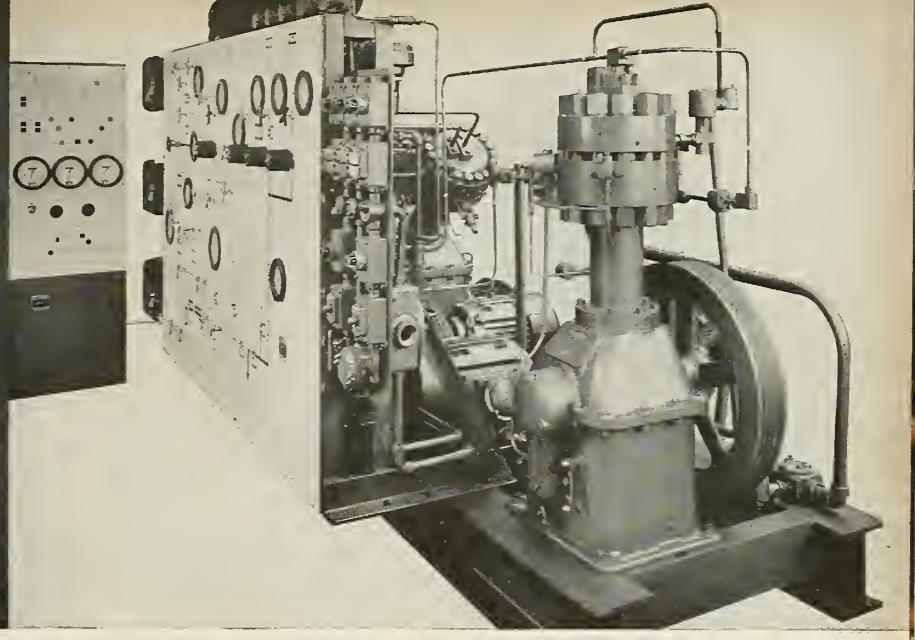
The Congressional Atomic Energy Committee will meet later this month to discuss among other things the issues President Kennedy faces in deciding whether to resume nuclear testing.

Indemnity Ceiling Removed

The House Space Committee approved a bill (HR 7115) granting NASA authorization to indemnify space contractors against "unusually hazardous risks," after removing a $500-million government liability limitation (M/R, June 12, p. 44).

The committee approved a subcommittee's recommendation to lift the limitation on grounds that the federal government has no authority to impose limits on court cases within individual states.

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In operation, either a helium-hydrogen mixture may be taken from the gas mixing vessel at elevated pressure for further pressurization, or air may be taken at atmospheric pressure for pressurization.

Gas is pumped at 9,000 p.s.i. into the high pressure storage vessel whose volume is about double that of the shock tube driver section. Suction is taken from the high pressure storage vessel, by two high-pressure booster compressors, for pressurization of the driver section. Pressurization can be accomplished within 11 minutes to 15,000 p.s.i.

A remote control panel is provided for filling the driver section with oxygen; pressurization of the driver section; and firing the shock tube.

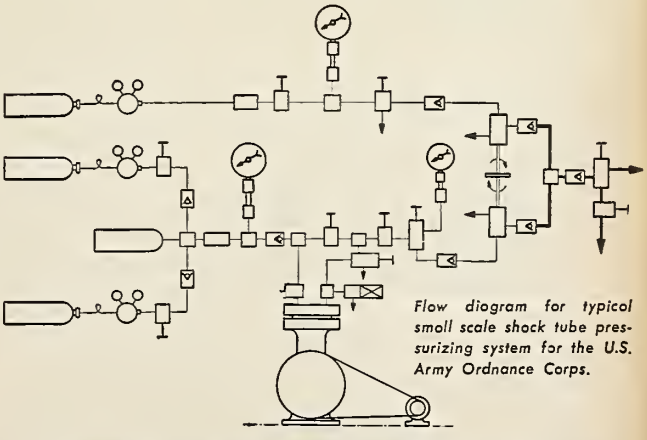
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Flow diagram for typical small scale shock tube pressurizing system for the U.S. Army Ordnance Corps.

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F102 PACKAGE, with three Model JR Gyros, is used in the F102 fighter.



F104 PACKAGE, designed around three Gnat Gyros, is used on the F104 Super Star Fighter.

F106 THREE-AXIS TURN RATE TRANSMITTER also uses three Gnats.

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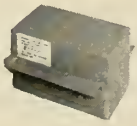
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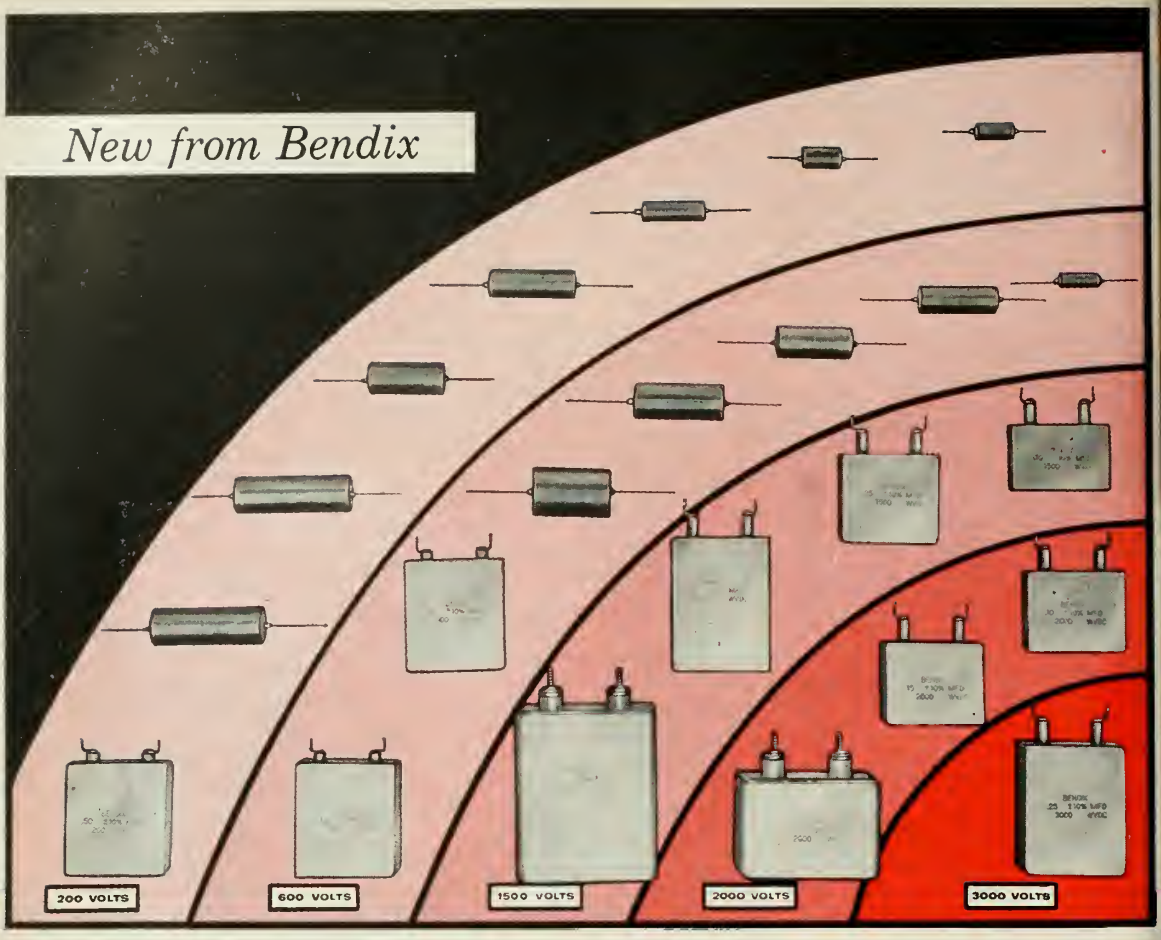
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The entire Mercury system was designed around the safety of the astronaut. Perched atop his capsule is an escape system powered by a GCR solid-propellant rocket. It will hurl the astronaut—capsule and all—up and out of trouble should the booster fail during launch or low-altitude flight. This GCR rocket must work. It does work. In more than 60 test shots, it has fired perfectly every time. This super-reliable propulsion system is one of several important solid-rocket projects now in production at GCR. In propulsion system research and development, GCR is at work on advanced programs for huge segmented boosters, hybrid rockets, ultra-high performance propellants, and a variety of other promising projects.

GRAND CENTRAL ROCKET COMPANY
REDLANDS, CALIFORNIA





E-200 HIGH TEMPERATURE CAPACITORS

Operable to +200°C.

The Bendix® E-200 series of lightweight, small size capacitors is designed for installations requiring a high degree of component reliability at operating temperatures as high as 200°C.

High temperature capability and mica-like electrical characteristics enable the E-200 series to withstand extremely high orders of AC in small envelope size at all ambients under 200°C.

The new series is designed and manufactured to a Bendix specification which is patterned after the high reliability specification MIL-C-14157B, proposed.

Hermetically sealed in tubular or rectangular housings, these capacitors offer superior resistance to mechanical and climatic environments.

E-200 CHARACTERISTICS: • Wound mica papers • Solid impregnants • Exceptional stability • High insulation resistance • Radiation resistance • Outstanding dependability

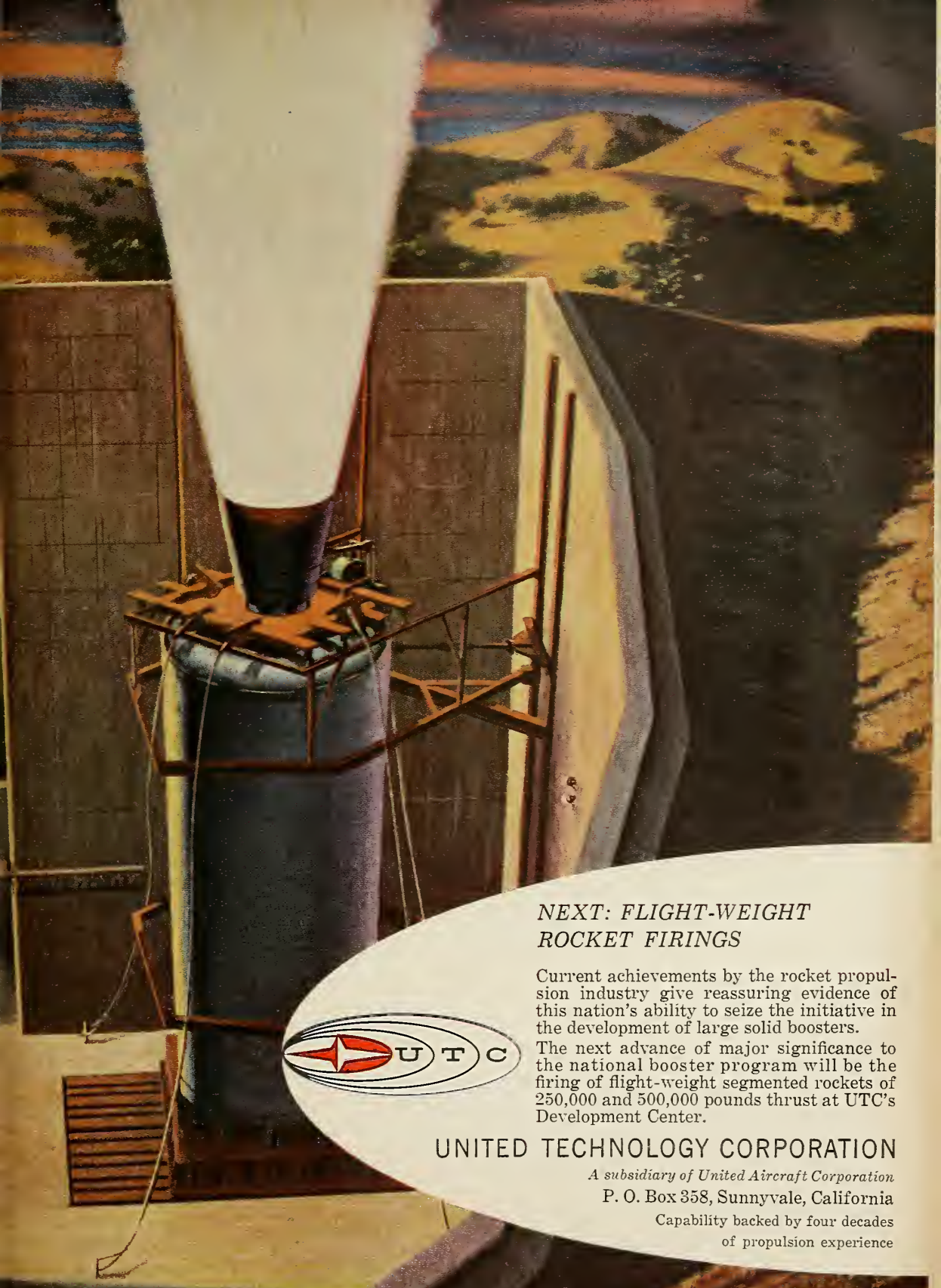
For full details, write

Scintilla Division
SIDNEY, NEW YORK

THE Bendix CORPORATION

Canadian Affiliate: Aviation Electric, Ltd., 200 Laurentien Blvd., Montreal 9, Quebec. Export Sales & Service: Bendix International, 205 E. 42nd St., New York 17, N. Y.

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NEXT: FLIGHT-WEIGHT ROCKET FIRINGS

Current achievements by the rocket propulsion industry give reassuring evidence of this nation's ability to seize the initiative in the development of large solid boosters.

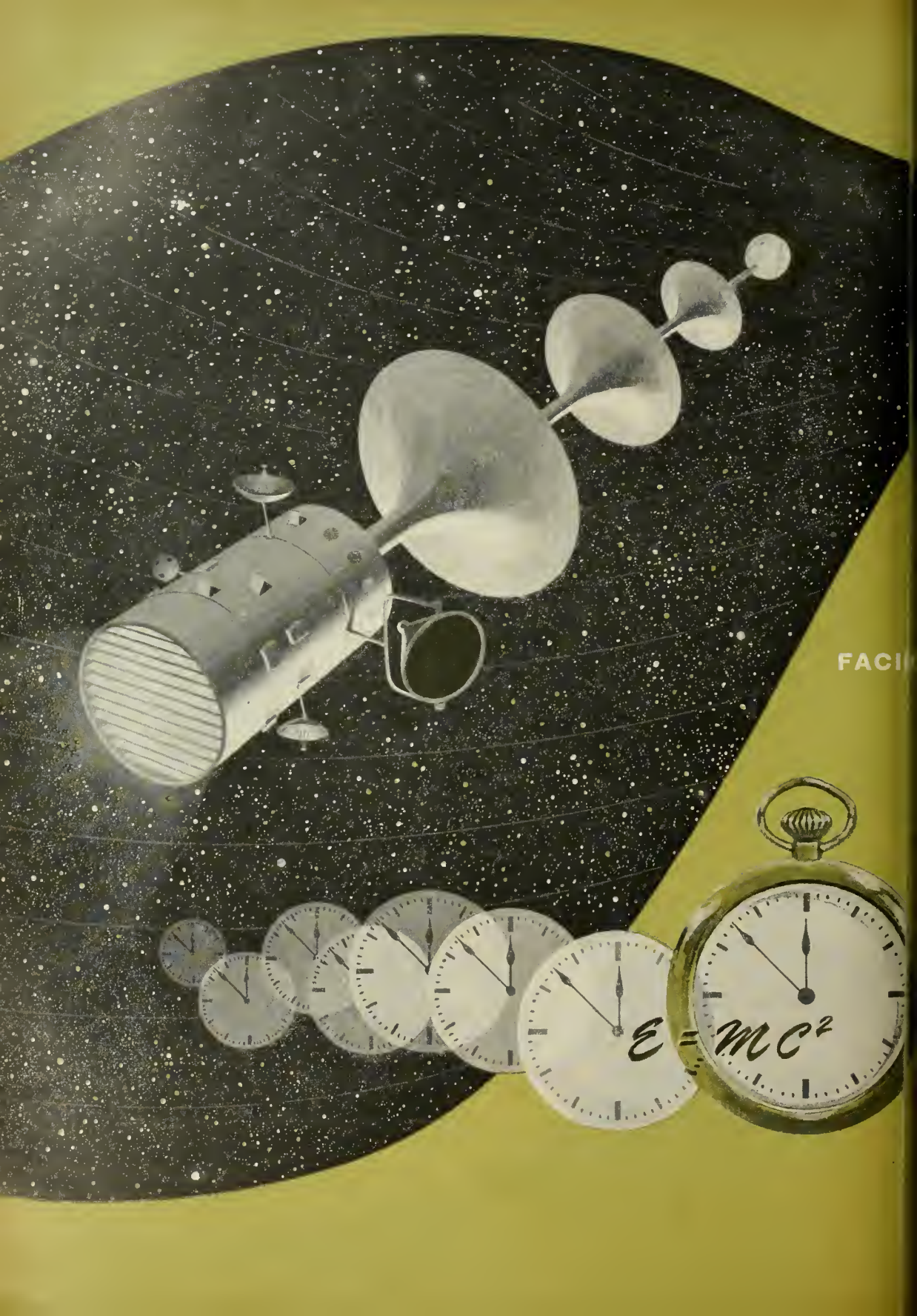
The next advance of major significance to the national booster program will be the firing of flight-weight segmented rockets of 250,000 and 500,000 pounds thrust at UTC's Development Center.

UNITED TECHNOLOGY CORPORATION

A subsidiary of United Aircraft Corporation

P. O. Box 358, Sunnyvale, California

Capability backed by four decades of propulsion experience


$E = mc^2$



E FOURTH DIMENSION IN PROPULSION DEVELOPMENT

Whether the universe has a "saddle shape," or any shape at all, is a matter of interesting conjecture. The matter of space travel, however, is the subject of intense experimentation. A nuclear/thermionic/ionic propulsion system, currently being studied at Lockheed Missiles and Space Division, might well become the power source for space vehicles.

Its design incorporates a nuclear reactor only one foot in diameter, generating heat at a temperature of 1850°K. This is transmitted to banks of thermionic generators, converting the heat directly into electrical energy for the ion beam motor which uses cesium vapor as a fuel. The entire system is designed without any moving parts, minimizing the possibility of failure.

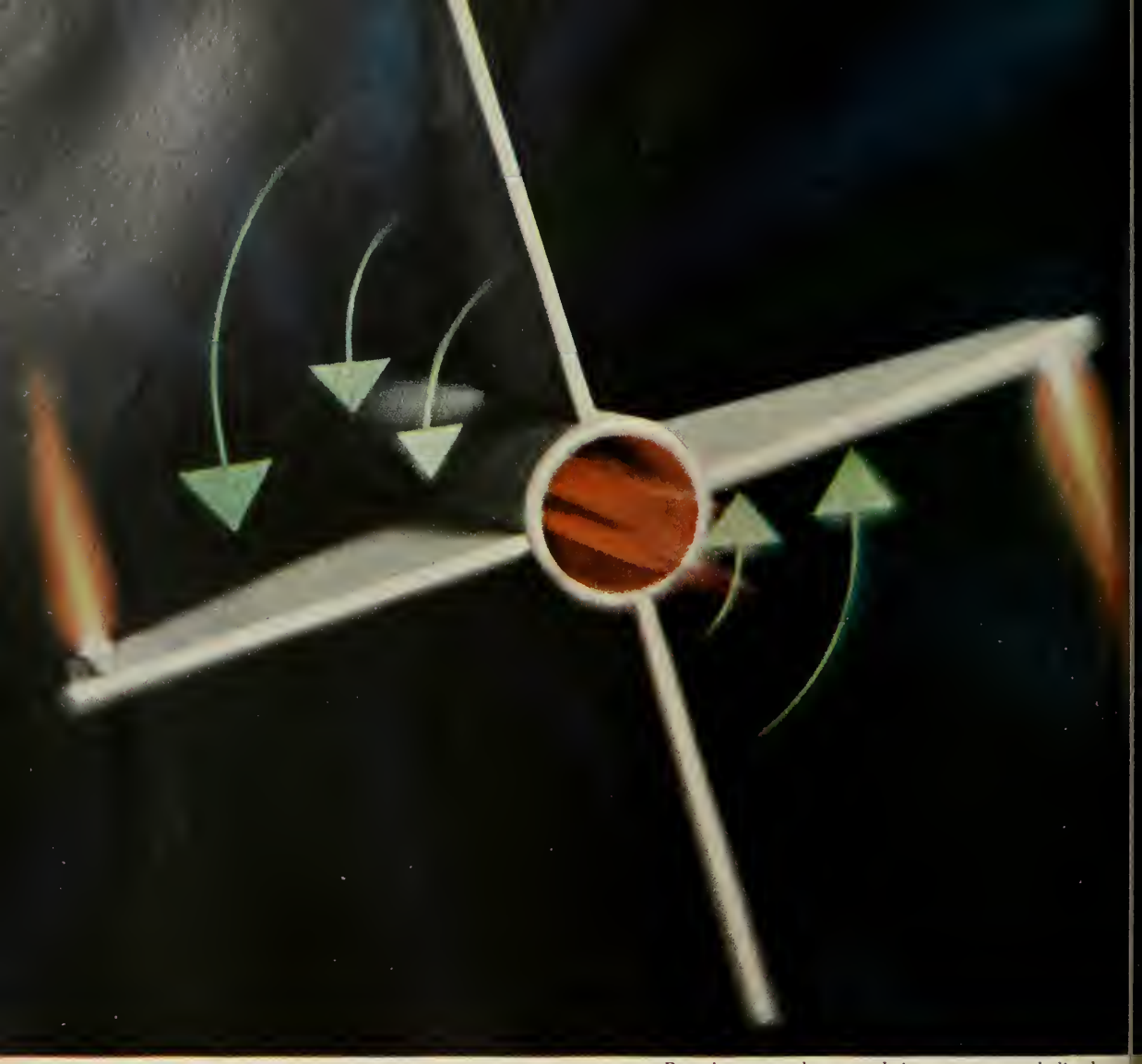
Lockheed's investigation of propulsion covers a number of potential systems. They include: plasma, ionic, nuclear, unique concepts in chemical systems involving high-energy solid and liquid propellents, combined solid-liquid chemical systems. The fundamentals of magnetohydrodynamics, as they might eventually apply to propulsion systems, are also being examined. Just as thoroughly, Lockheed probes all missile and space disciplines in depth. The extensive facilities of the research and development laboratories—together with the opportunity of working with men who are acknowledged leaders in their fields—make association with Lockheed truly rewarding and satisfying.

Lockheed Missiles and Space Division in Sunnyvale and Palo Alto, on the beautiful San Francisco Peninsula, is an exciting and challenging place to work. For further information, write Research and Development Staff, Department M-24D, 962 West El Camino Real, Sunnyvale, California. U.S. citizenship or existing Department of Defense industrial security clearance required. All qualified applicants will receive consideration for employment without regard to race, creed, color or national origin.

Lockheed / **MISSILES AND SPACE DIVISION**

Systems Manager for the Navy POLARIS FBM and the Air Force AGENA Satellite in the DISCOVERER and MIDAS Programs

SUNNYVALE, PALO ALTO, VAN NUYS, SANTA CRUZ, SANTA MARIA, CALIFORNIA • CAPE CANAVERAL, FLORIDA • HAWAII



Reaction controls at work in space — symbolized.

STEERING GEAR FOR MERCURY ASTRONAUTS

Conventional aircraft control surfaces will not guide space ships and capsules. Rudders, ailerons and elevators find no resistance and hence produce no reaction to their movements where there is no atmosphere. Even at altitudes only half way up, they are sluggishly ineffective.

The accepted answer to a dependable steering mechanism for astronauts is a system of jet reaction controls developed and produced by Bell Aerosystems Company. First used on Bell's own supersonic X-1B several years ago, the system has been greatly improved and adopted for the X-15, the Mercury man-in-space project and other space vehicles.

Through strategically located, low and high thrust (1 to 1500 pound) rocket engines, Bell's reaction controls not only position and guide the ship by controlling the roll, pitch and yaw, but they also provide for orbit changes and retro-thrust. Some of the jets are throttleable while others can be operated in combination to provide the astronaut positive and flexible control.

This revolutionary steering gear for space, available using monopropellants or high energy bipropellants, is just one of many advanced projects which are currently engaging the diversified talents of Bell Aerosystems Company in the fields of rocketry, avionics and space techniques. Engineers and scientists seeking challenging, long-range career opportunities can find them at Bell.

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BUFFALO 5, N. Y.
DIVISION OF BELL AEROSPACE CORPORATION
A TEXTRON COMPANY

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SAC

Keeping a roof over your head

The men of SAC literally keep a roof over all our heads . . . their presence providing continuous protection. This deterrent to aggression is no simple task; yet it is the mission of the men and planes of the Strategic Air Command. ■ As individuals or as industries, we all contribute to maintaining and improving this vast defense force. AC Spark Plug Division is presently contributing by developing and producing a new all-weather Bombing Navigation System for SAC's first-line bomber, the B-52. This radar-oriented system will enable the B-52 to make high speed bombing runs at low levels, circumventing hazardous ground obstacles. ■ This new product by AC Spark Plug Division is helping SAC make the roof stronger.

AC SPARK PLUG ⚛ THE ELECTRONICS DIVISION OF GENERAL MOTORS

Inertial Guidance for Titan II, Thor and Mace. Bombing Navigation for B-52 and B-47.

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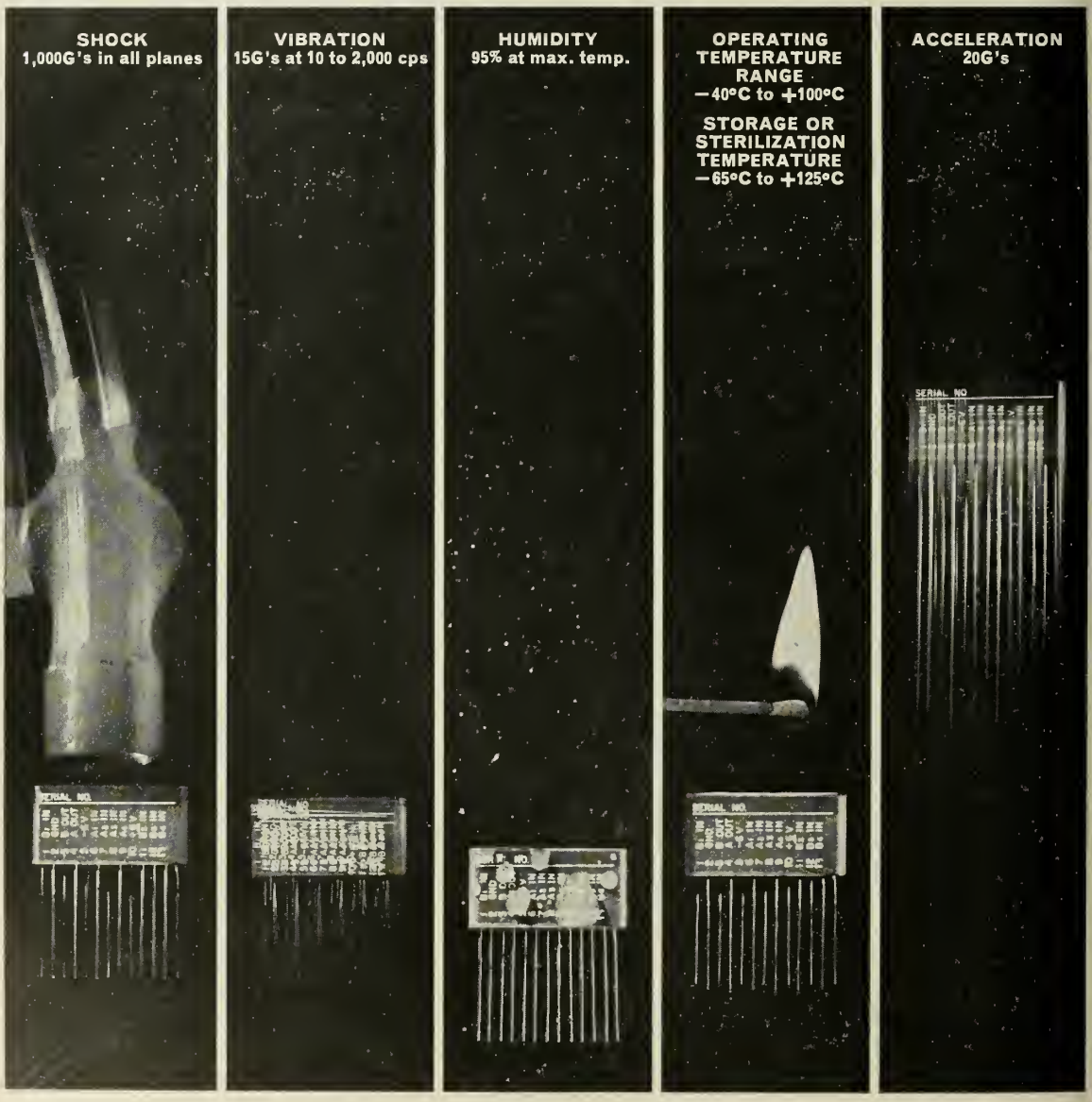


If you are an experienced radar engineer interested in working on advanced airborne navigation systems, please contact Mr. G. F. Raasch, Director of Scientific and Professional Employment, 7929 S. Howell, Milwaukee 1, Wis. All qualified applicants will receive consideration for employment without regard to race, color, creed or national origin.

LOW POWER SILICON DIGITAL MODULES

ENVIRONMENTALLY PROVED . . . AVAILABLE NOW!

Delco Radio's new silicon digital modules operate on less than 4 mw. of power per logic stage. They are rugged enough to withstand extreme environmental conditions and are small and lightweight. Encapsulated in light foamy epoxy, each module weighs less than 12 grams and occupies less than one-half cubic inch. The basic set of modules includes a bistable multivibrator, a diode NOR gate, a power driver, a monostable multivibrator and an astable multivibrator. From these basic units larger computer subassemblies can be assembled, such as shift registers, adders, binary counters, decimal counters and timing devices. A range of applications—from small scale switching circuits to large computers can be satisfied with these modules. Environmentally proved to:



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Physicists and electronics engineers: Join Delco Radio's search for new and better products through Solid State Physics.

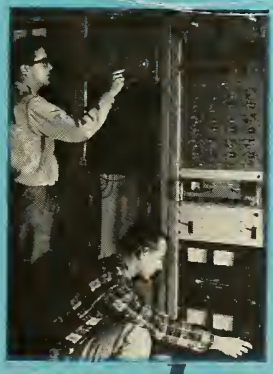
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men at work on a new approach to the stars

As principal instrumentation contractor for Project Rover, EG&G is already at grips with the central problems of nuclear propulsion for deep outer space exploration. A control, instrumentation and data acquisition system designed and operated by EG&G is of basic importance in the full-scale testing of Rover's KIWI prototype engines, designed by the Los Alamos Scientific Laboratory. The EG&G system is being effectively applied to the solution of problems of heat transfer, neutronics, fluid dynamics and general control.

EG&G instrumentation is also at work in the application of nuclear energy to industrial uses (Gnome) and in the international program for detection of nuclear explosions (Vela). In oceanography, EG&G equipment is probing the ultimate ocean depths. An informative brochure which describes the breadth and depth of EG&G's capabilities is available on request.

For information about employment prospects with this unique, vigorous organization write in confidence to Lars-Erik Wiberg. All qualified applicants will receive consideration for employment without regard to race, creed, color or national origin.

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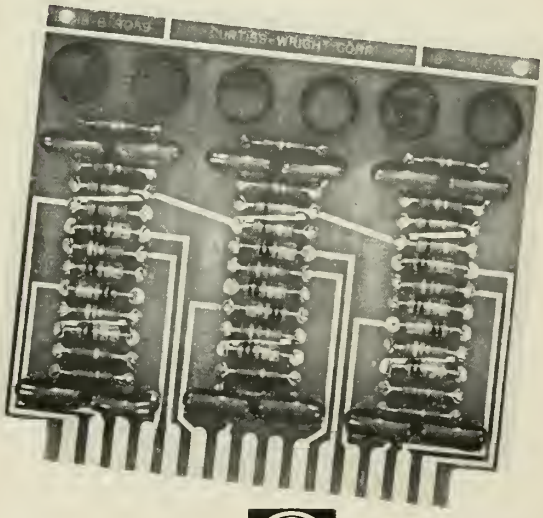
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Insulation news from Johns-Manville

Now Min-K® is flexible!

THE INSULATION WITH A LOWER CONDUCTIVITY THAN STILL AIR IS NOW AVAILABLE IN BLANKET AND TAPE FORMS FOR UNLIMITED NEW APPLICATIONS

Min-K, the unique insulating material developed and produced by Johns-Manville, now has an added quality . . . flexibility! Min-K is a new concept in missile insulation. The higher it flies, the better it insulates. Min-K's thermal conductivity drops as atmospheric pressure decreases. Its superior performance has been proved in hundreds of operational U. S. missiles.

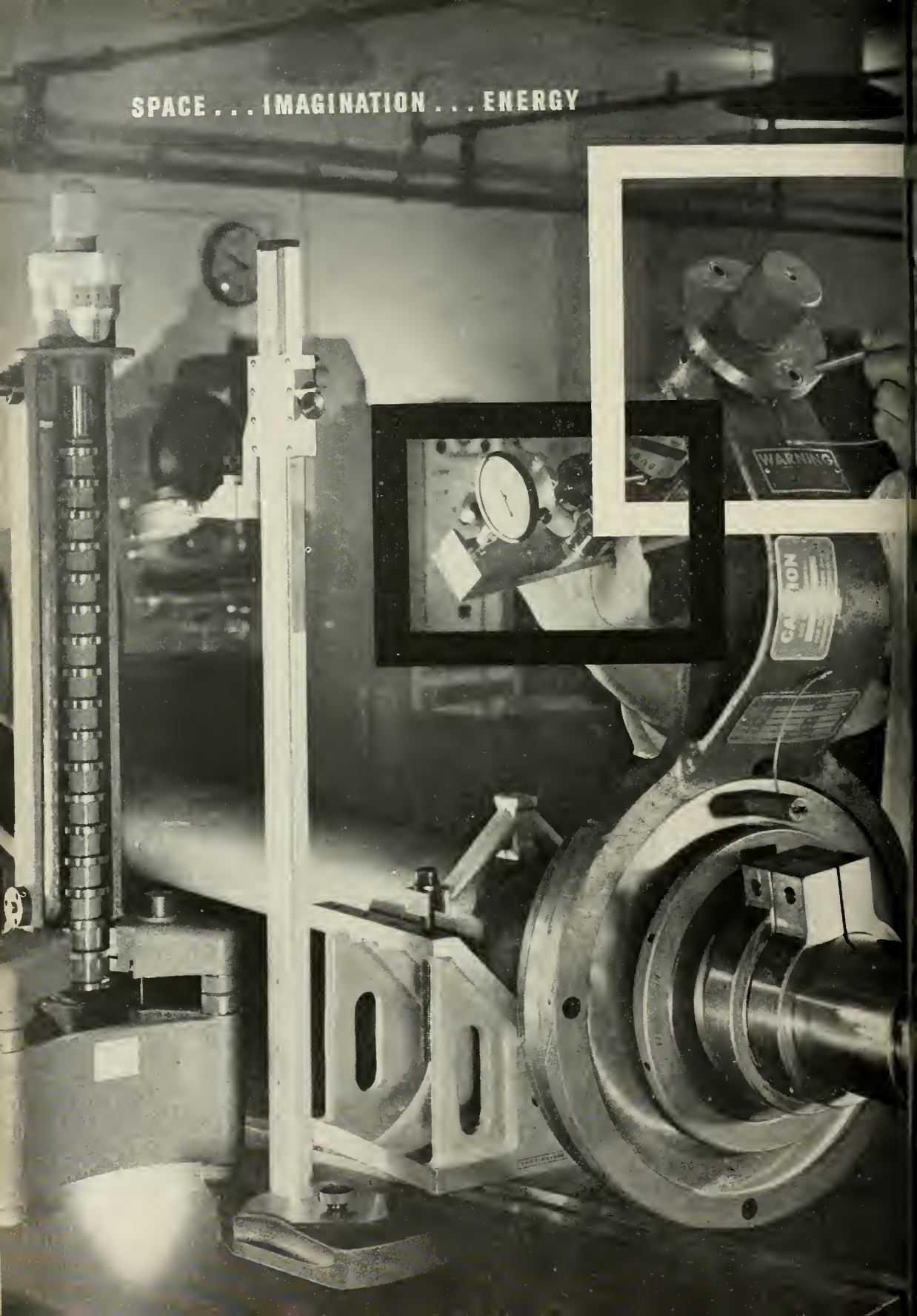
New Flexible Min-K offers many special advantages. For example, it is the ideal way to lower prototype costs. You can test performance without the expense of special tooling. The flexible blankets lend themselves to bonding, lamination with reinforced plastics, service coatings and as a component of insulation systems. Further, Min-K can be tailor-made to wrap around a cylinder, cone or other geometric shape. And, it is also available in $1\frac{1}{2}$" and 2" tapes for spiral winding on a duct or pipe.

Because of the added quality of flexibility, Min-K's unique insulating characteristics now can be used in virtually unlimited new applications. For full details on Flexible Min-K, Min-K and other J-M aviation insulations, write Johns-Manville, Box 14, New York 16, New York. In Canada: Port Credit, Ontario. Cable address: Johnmanvil.

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WARNING

Millionth-Inch Accuracies For Million-Mile Journeys





The Primary Standards Laboratory at Hercules' Bacchus plant has a fundamental accuracy of four one-millionths of an inch. This is second order only to the National Bureau of Standards in Washington. Here is the calibration point for all measuring, gaging, machining, and assembly of the third-stage motor for Minuteman, the advanced second-stage motor for Polaris, and in development of the ultraprecision retrorocket for Ranger.

There is good reason for such stringent physical accuracy. Missiles or space vehicles—whether they are to travel hundreds or thousands of miles, or into far distance—must traject with pin-point precision. And, unless the final stage is manned, or under cybernetic control, the governors of its final course are purely ballistic: the force, time, and direction with which its motor was originally endowed.

The factors of force and time are subject to chemical prediction; precision and dependability in this area are the backbone of Hercules' current contributions to missilry. Direction of application, however, is a purely physical thing, and calls for new orders of accuracy in manufacture. It is for this reason that the Primary Standards Laboratory at Bacchus is one of the key units of the Chemical Propulsion Division.

Chemical Propulsion Division
HERCULES POWDER COMPANY
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Hercules Tower—910 Market St., Wilmington 99, Del.

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for precision...economy...reliability

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Part of one of the country's largest such machine tool installations, its output is devoted exclusively to the economical production of precision mechanical and electromechanical components . . . reliable components of intricate control systems that guide many of the nation's successful missile and satellite "shots" and that will guide SATURN space explorations.

Advanced machine tools of this type are typical of Sperry Farragut's modern production facilities, which include one of the most extensive and up-to-date "clean room" areas for precision assembly work, and comprehensive equipment for product environmental evaluation.

At Sperry Farragut, full realization of equipment potentialities is assured by a highly trained staff with wide experience in guidance system production —skilled personnel motivated by a sense of urgency and dedicated to achieving the highest quality and reliability attainable.

Contracting agencies and government contractors are invited to talk over application of Sperry Farragut facilities and capabilities to their specific projects. Our liaison engineers will welcome an opportunity to discuss your requirements. O.3

Capabilities and facilities for study, design, evaluation, prototype construction, and final quantity production of precision systems, subsystems, and components for:

- *Missile guidance and control*
- *Fire control*
- *Aircraft instrumentation*
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SPERRY FARRAGUT COMPANY

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A lot of jobs—especially in missiles—need room to complete. It takes inner space to prepare for outer space. It takes skills and long experience to work with metals in the large way some of your jobs require.

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General American has produced lox vessels, radiation shields, atomic waste evaporators and missile equipment components. We are known around the world for the tanks we have fabricated and erected—tanks for storage of petroleum products, acids, chemicals and water; tank cars for transportation of any kind of liquid. We are constantly at work on projects that involve cutting, forming, milling and stress relieving of large metal structures. Our background in aluminum and alloy steels is considerable.

When a job requires custom fabrication of metal—any metal—we generally can handle it faster and better than any one else. We would like to work for you.

Plate & Welding Division

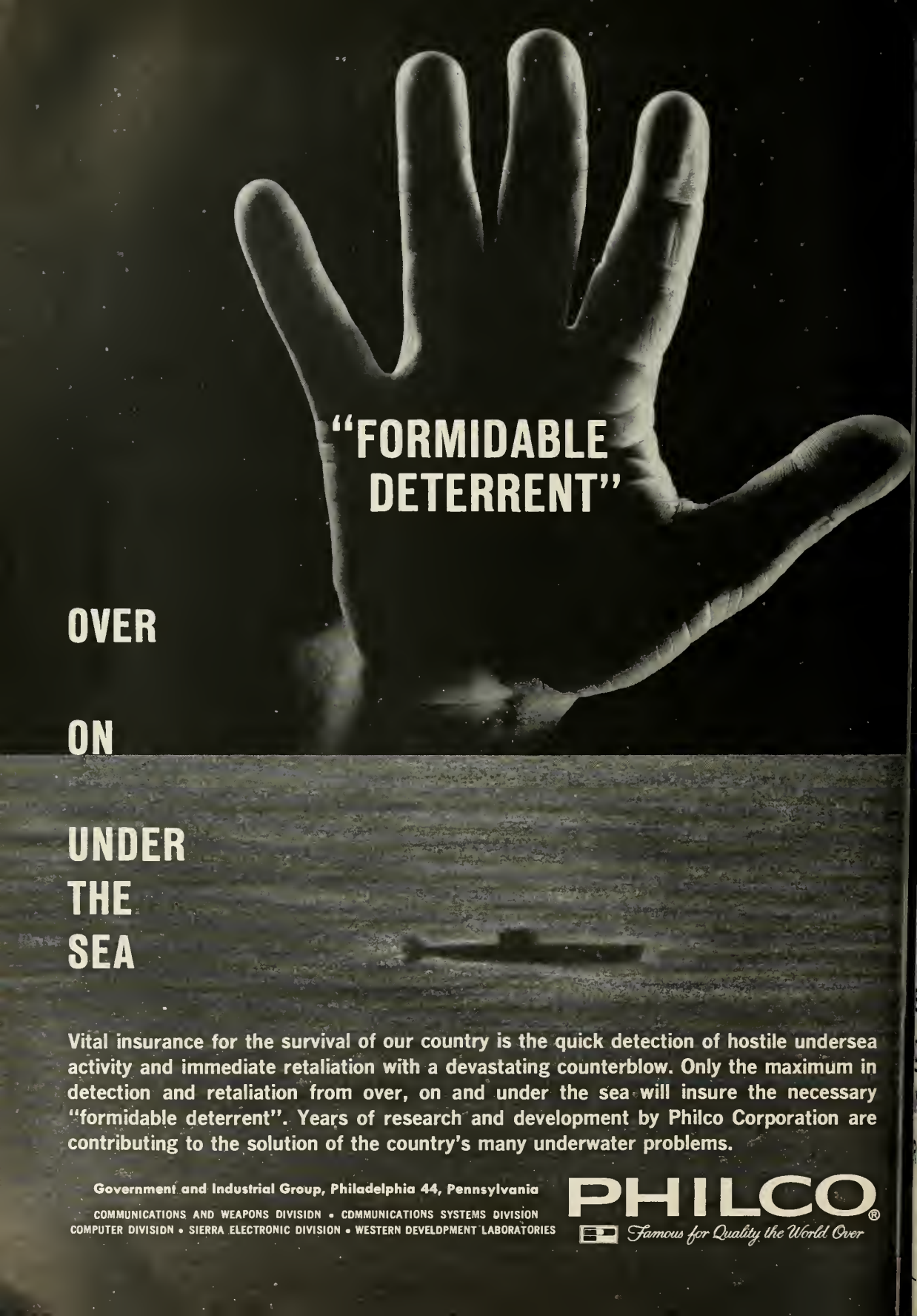
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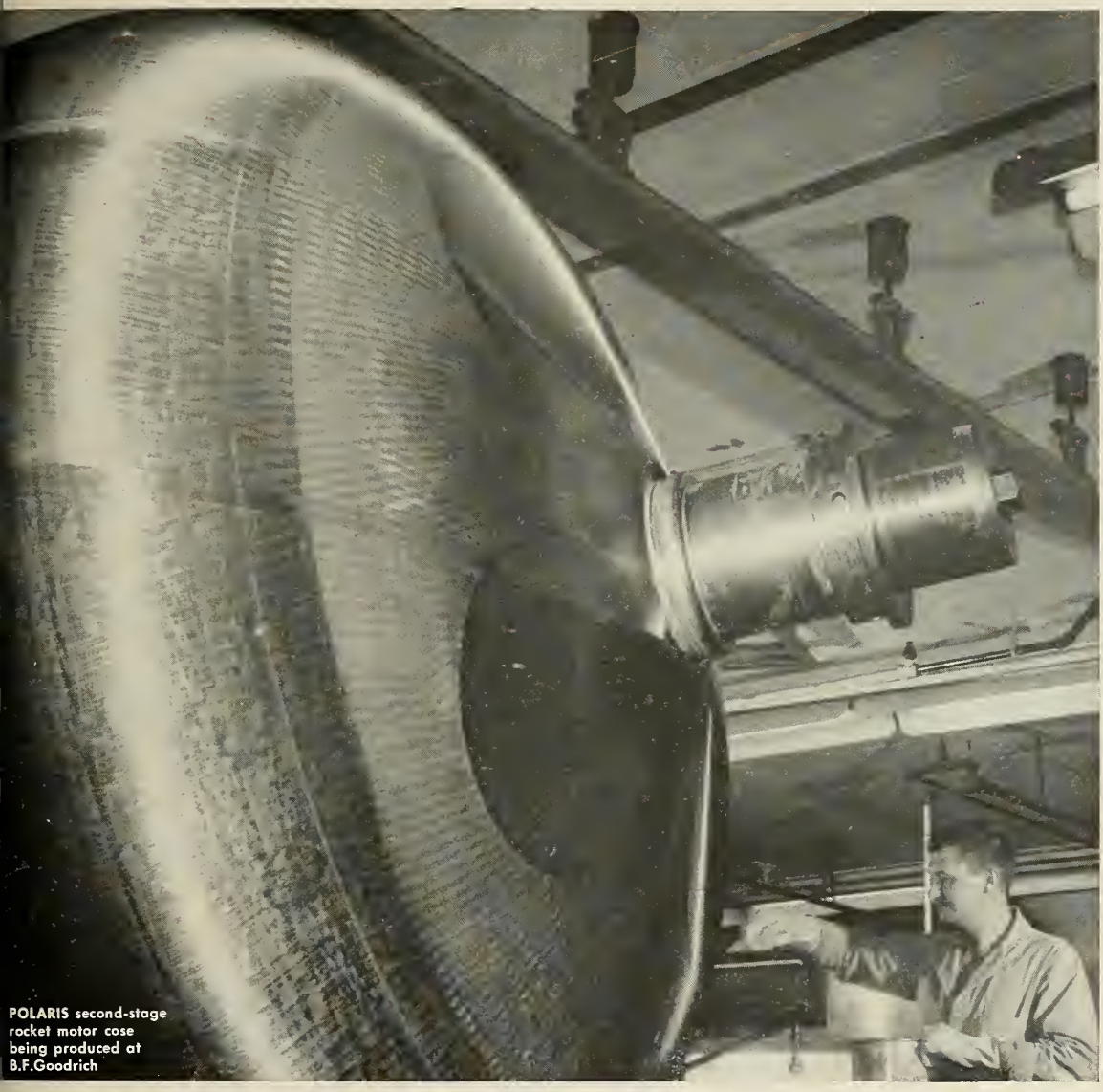
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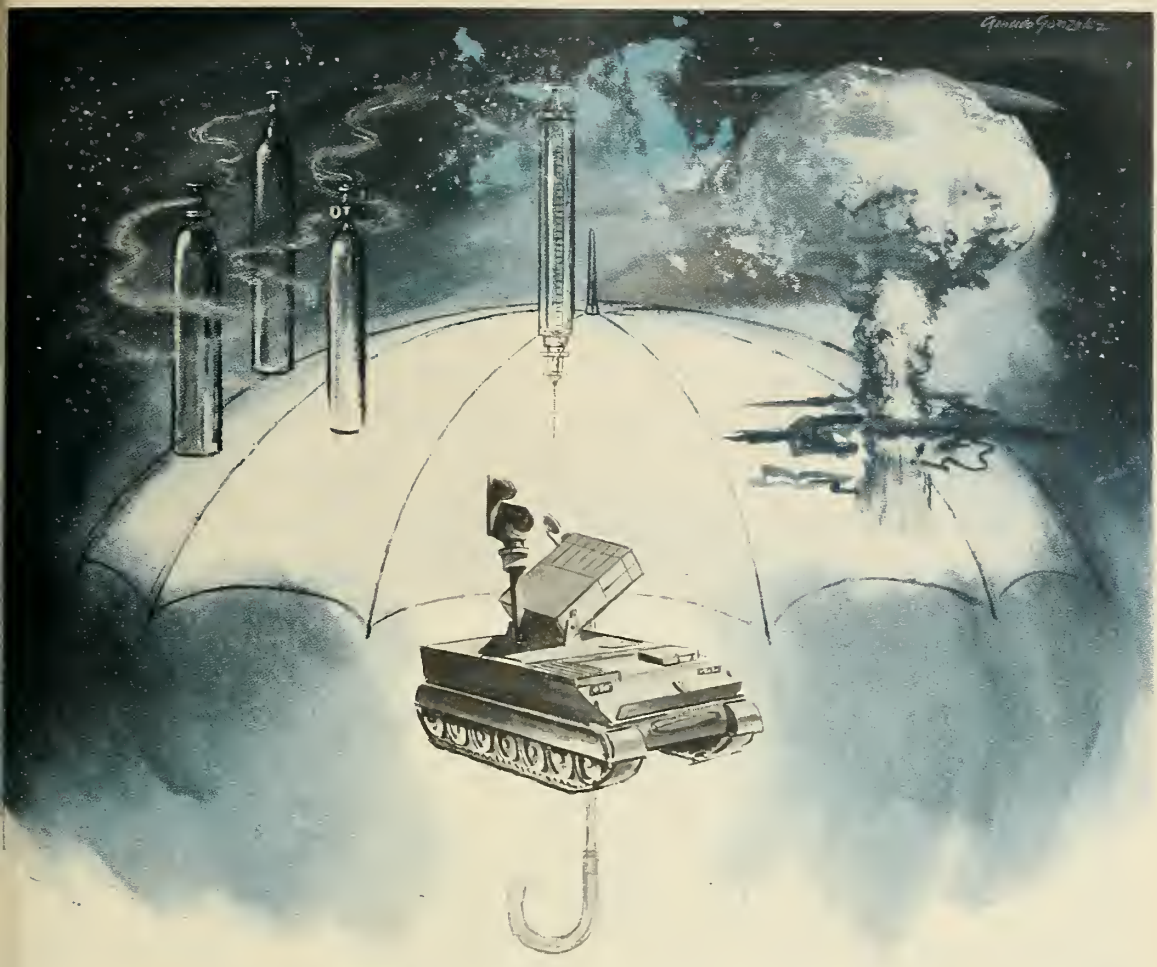
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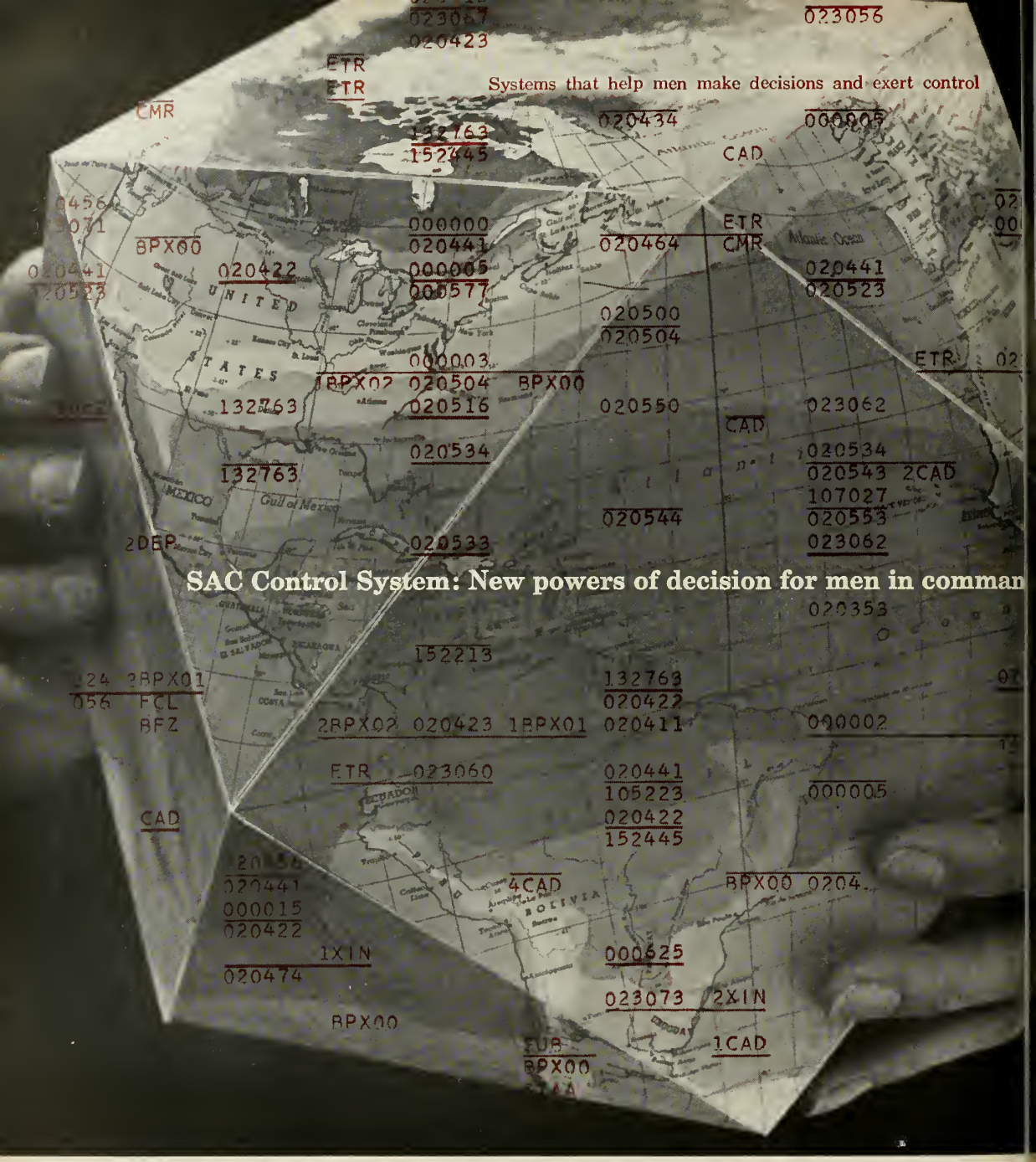
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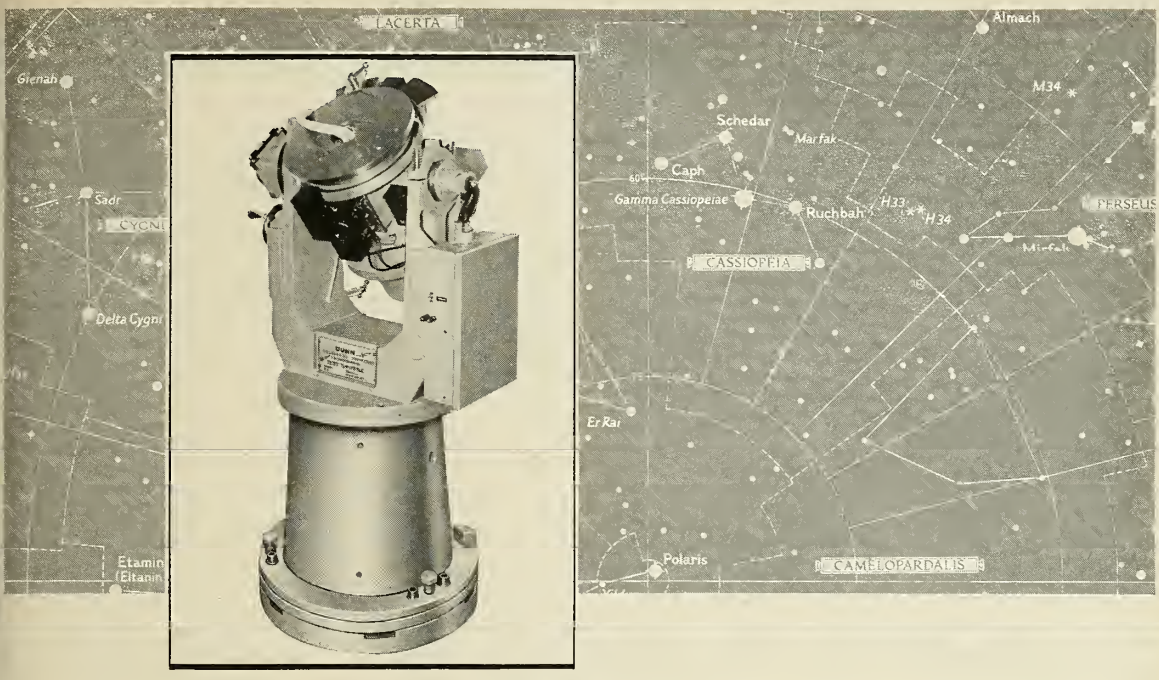


This world-wide communication network will help Strategic Air Force leaders exercise command and control almost in response to events of the moment. Yet the forces involved are dispersed throughout the world, the volume and complexity of information unprecedented. ¶ The SAC Control System will be a product of the new technology of automated information processing assistance. We have helped create this new technology, beginning with our work on SAGE. In projects such as SAACS and SAGE, we perform system analysis, information processing system design, and training of personnel in system use. And as a continuing effort, we carry on research into future generations of these control systems.

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SDC
SYSTEM DEVELOPMEN CORPORATIO

The globe shown is the Dymaxion projection by R. Buckminster Fuller. It depicts the spherical world as a flat surface with a minimum of distorti



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As a sequel to the well-known Dunn oil-bearing T818 table, the Dunn T900 makes possible for the first time performance evaluation of inertial grade gyros having drift rates of the order of .001°/hr. Advances in the design of the T900 table drive and rate read-out provide precise table rotation and digital information.

The Inherently Compensated Air-Bearing Design eliminates the bearing flutter problem, and makes possible bearing stiffness of the order of 5,000,000 pounds per inch, thus limiting table top deflections to fractions of arc seconds. Use of air bearings provides zero stiction, minimal viscous drag, and eliminates mechanical bearing frictional uncertainties, permitting rate deviations no greater than 0.003°/hr. at frequencies of less than 0.1 cps. Orthogonalities are 5 seconds or less, and table axis angular wobble is less than 1 second of arc.

This new table represents the most advanced stage of the inertial guidance system testing field. Other fluid-bearing tables are available... write for data sheets.

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- inertial products
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A LINK WITH THE PAST

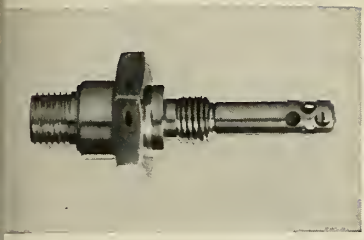
Remember when you and kids in the neighborhood used to hook up a couple of tin cans with string and communicate from across the street? It wasn't fancy but it worked. Today, when uninterrupted communication between moving or fixed stations is so essential, Vitro has developed a link as simple and reliable as the old tin can technique. Nothing fancy, just a fault-free wire link system that assures maximum protection against such factors as outside interference, abrasion, jamming and foul weather conditions. Light weight packaging and snarl-free payout combine to make the wire link system, perfected by Vitro, as versatile as it is reliable. ■ In today's troubled world we're no longer playing games, but two lessons we learned from tin cans — simplicity and dependability — are still a very real concern in station-to-station communications.

Vitro LABORATORIES

Division of Vitro Corporation of America

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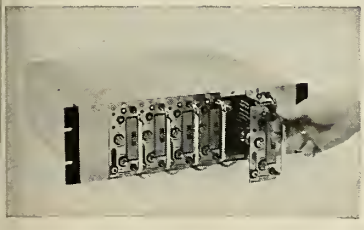
Temperature Transducer



Small probe-type device for high and low temperature applications where high pressures and severe flow conditions are imposed. Precise liquid or gaseous measurements to 800°F. Tiny sensing element of deposited platinum film allows high base resistance, extreme linearity, wide range capability, and fast response. Approved for ICBM environments.

Microdot Inc., 220 Pasadena Avenue, South Pasadena, California.

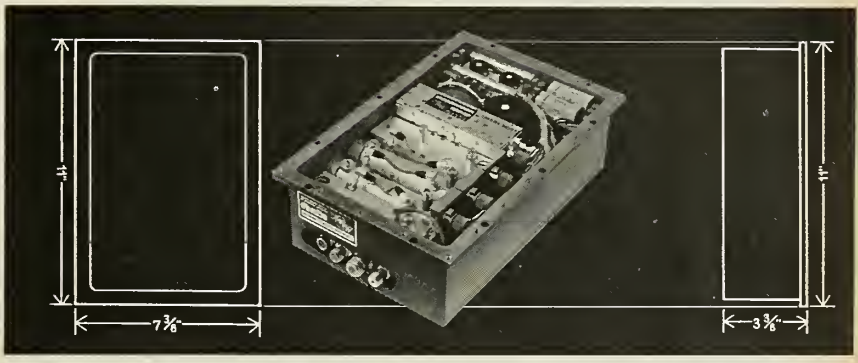
Transducer Signal Conditioning



Two new transducer and strain gage signal conditioning units feature radically different packaging concept at low cost per channel. Both the PS-290 Power Supply and PB-290 Power and Balance Unit incorporate plug-in card circuits for up to eight channels in a 19" rack, 5¼" high. Bridge completion balancing, and calibration resistors are easily accessible from the front. Output ripple is less than 500 microvolts peak-to-peak, or 200 microvolts RMS. Line regulation is less than 0.02%. Isolation is less than 0.01 microamps of 60 cycle current. Output impedance is less than 0.05 ohm.

Microdot Inc., 220 Pasadena Avenue, South Pasadena, California.

VHF-UHF TRANSMITTERS



Proved in history's most demanding environmental laboratory — outer space — the custom designed unit shown above is typical of the development skill and production capability available from Microdot. The unit shown in miniaturized, pressurized, and features a solid state power supply that cannot be damaged by input/output overloads. Units are available in a complete range of modulation — CW, FM, Phase, and Pulse, with frequency coverage 100 to 5000 mc/s and output from 100 mw to 10 watts.

Telemetry Capabilities at Microdot have been dramatically expanded with the recent acquisition of Spectralab Instrument Company. The highly regarded development skill, production capability, and working experience of Spectralab in the field of VHF and UHF cavities and related instrumentation is available from Microdot's Instrumentation Division. This equipment, outstanding in its attention to miniaturization and ruggedness, is a vital part of such important projects as Pioneer V, Jupiter, Atlas, Pershing, Redstone and Echo I.

UHF Telemetry Transmitters, Models 2406 and 2409, use a unique, automatically stabilized circuit, with the output frequency referenced directly to a quartz crystal. This approach allows a greatly reduced size compared to the multiplier chain conventionally required to achieve crystal stability, as well as increased reliability due to a fewer number of parts.

The transmitters have their own solid state power supply designed to provide a high ratio of rf output power to total power input. The frequency modulation circuitry is sufficiently linear to introduce completely negligible distortion to the modulation signal. For further information, Call Microdot or write for catalog sheet TT-1.

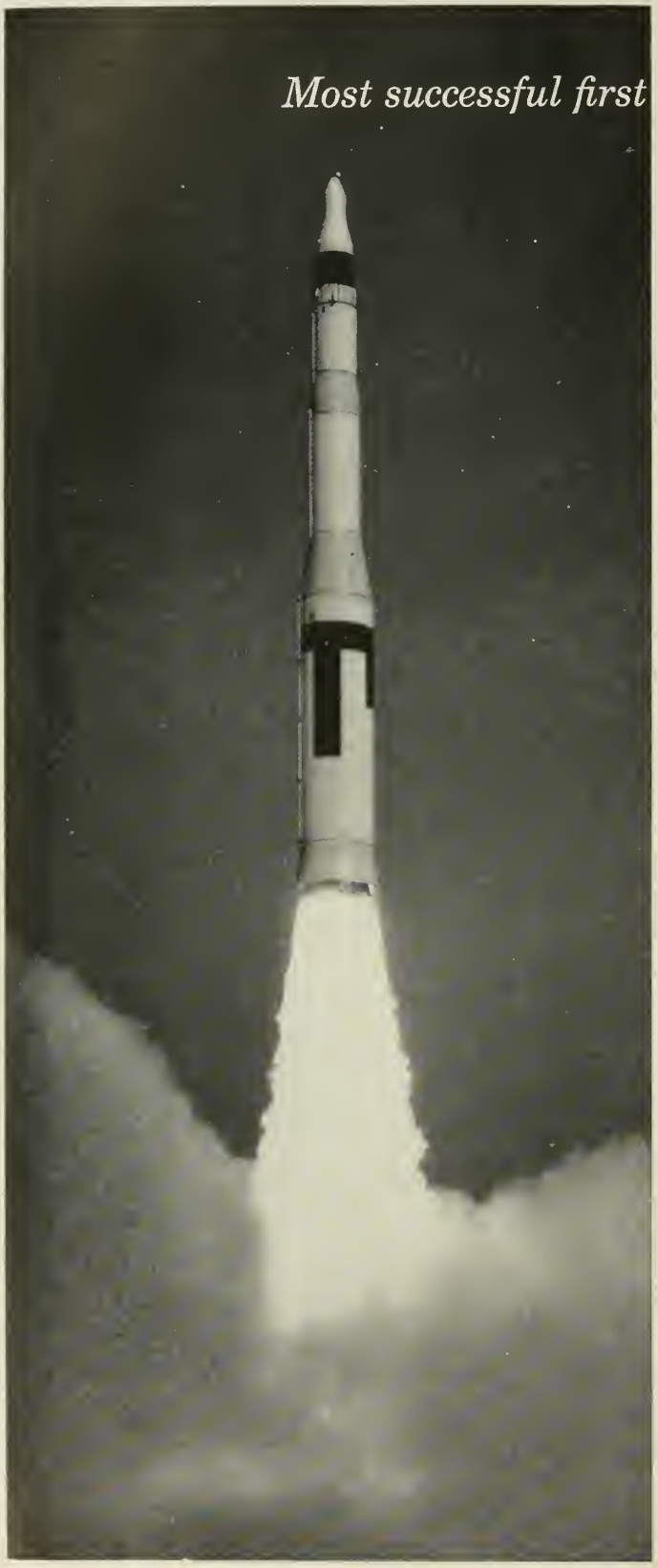
SPECIFICATIONS

Frequency Range:	
Model 2406	2200-2300 mc/s
Model 2409	1435-1535 mc/s
Frequency Stability:	±0.001%
Power Output:	10 watts
Power Output Stability:	1 db
Modulation:	PCM/FM, PAM/FM, FM/FM
Input Voltage:	28 vdc
Temperature Range:	−40°C to +70°C
Vibration:	10 g, 5-2000 cps
Size:	3⅜" x 7⅜" x 11"

MICRODOT INC.

220 Pasadena Avenue, South Pasadena, Calif.

MUrray 2-3351 SYcamore 9-9171



Most successful first flight in missile history

Historic first firing of Minuteman, the U. S. Air Force's first solid-fuel intercontinental ballistic missile. Completely successful, this flight marked the first time in history that so many missile components were tested on initial flight: three rocket stages, full guidance system and nose cone. Compact, quick-firing Minuteman missiles, scheduled for operational status by mid-1962, will be stored ready for instant action in underground silos and on special trains. Boeing is responsible for Minuteman assembly and test, design and development of launch control and ground support systems.

Capability has many faces at Boeing



SKY TANKER. Boeing KC-135 jet tanker refuels bombers and fighters to provide greatly extended range. This versatile Boeing jet is also a military transport. The United States Air Force recently ordered 30 C-135s, cargo-jet version of KC-135



TESTING. TESTING. Boeing electronic system tests effectiveness of radar and countermeasure systems. Boeing is widely active in electronics—in research, design, manufacture and test, and in the assembly of systems for Air Force's BOMARC and Minuteman missiles, and Dyna-Soar space-glider

BOEING



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Subcarrier oscillators designed and built by Dorsett Electronics are standard equipment in the FM telemetry systems of both the Advanced Terrier and the Tartar missiles, built by Convair/Pomona, Convair Division of General Dynamics.

The same high standards of electrical performance and quality workmanship that go into the telemetry components being delivered to Convair/Pomona are found in all Dorsett-built telemetering equipment. That is why more and more of the nation's missile and satellite builders are specifying Dorsett equipment.

For more information on the products and capabilities of this fast growing team of telemetering specialists, including the new facilities at Dorsett's West Coast Division—American Missile Products Co., Inc., write today.

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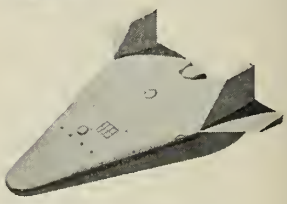
Lunar VTOL Vehicle. A rocket-propelled craft designed to collect lunar ore specimens.



Nuclear Space Ship. An unconventional design by Douglas with living quarters around the ring at the bottom. On landing, it would ease down, ring first.



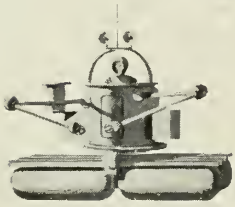
Nuclear Space Ship. A Douglas design for a space ship with crew quarters and control rooms in the nose, nuclear reactor in the rear.



Supply and Escape Vehicle. A compact re-entry vehicle to supply orbiting space stations or to return crews to earth.



Nuclear Space Ship. A future, medium-thrust, nuclear-electric space ship for one-year interplanetary round trips (Martian and Venusian).



Lunar Service Vehicle. Travels like a "swamp buggy" on inflated rollers. Mechanical arms provided to handle outside chores.



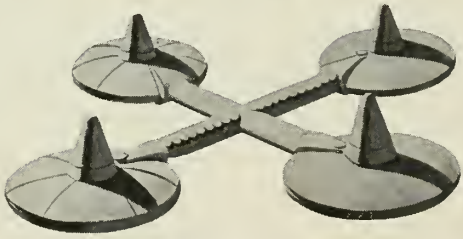
Douglas Thor. Designed as a military IRBM, this dependable missile is the workhorse of the Space Age.



Saturn. First U.S. vehicle designed to put tons of payload into orbit . . . or onto the moon. Douglas-built second stage is as tall as a 4-story building.



Lunar Cargo Handlers. Would load lunar ore samples into containers to be towed back to earth by rockets.



Space Observatory. Sections of this Douglas-designed space station would be sent into space in rockets and be joined together in orbit.



Lunarmobile. Donut-shaped exploration vehicle to use rocket power in space and tractor treads on the moon's surface.

Eleven ways to outwit the law of gravity

When the Space Age dawned, Douglas was ready with specific proposals for space equipment either completed or in advanced stages of development. (Some appear above.)

These Douglas proposals were based on *realistic* estimates of the capabilities of men and materials. They are the valued dividends of the company's considerable experience, gained from the design and production of 30,000 missiles and rockets. These include the Douglas *Thor*, an IRBM which has been totally successful in 86% of its tactical and space firings over the past two years.

Today, Douglas looks ahead to other exciting challenges from its firm position of leadership in the conquest of Space.

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MISSILE AND SPACE SYSTEMS • MILITARY AIRCRAFT • DC-8 JETLINERS • RESEARCH AND DEVELOPMENT PROJECTS • GROUND SUPPORT EQUIPMENT • AIRCOMB® • ASW DEVICES



He's solving a real estate problem

This AMF engineer's job is determining how best to move big missiles off shore for launching. Should they be floated out horizontally, flooded to an upright position, and then launched? Or, would it be more feasible to barge them out? Might they be moved to or assembled on "Texas Towers," or would a causeway or simply land-fill be the answer?

Behind the project is our shrinking real estate at launching sites, plus the hazards inherent in launching Saturn-sized missiles (and the coming, nuclear-powered missiles) near other installations. Off-shore launching may be the answer.

Feasibility studies of all types are an AMF specialty. What kind of remotely controlled machinery is required to service nuclear-powered aircraft? What kind of habitation could be built on (or under) the surface of the moon? What sort of machines (manned and unmanned) could survey the moon's surface without, for example, falling into a fissure? What is the best way to assemble a space station? All these are problems AMF engineers are presently investigating.

If your problem is the first of its kind, AMF will not, of course, have met it before. But AMF's long experience in accepting totally unique challenges gives it an advantage enjoyed by few other organizations concerned with ground support, launchability and space environment. To get further information write American Machine & Foundry Company, 261 Madison Avenue, New York 16, N. Y.

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Sr. Chemist or Chemical Engineer with experience in vacuum evaporation, vapor reduction, and electro-deposition of coatings on metallic and non-metallic base materials or experience with any of the coating methods. Must be capable of developing processes providing uniform adherent deposits of materials having unique properties suitable to advanced gyro and circuitry development.

Sr. Systems Analyst. Must be well grounded in math and have 4 years' experience in analysis of aircraft stability and control. Familiar with both analog and digital computers and capable of applying various types of stability criteria such as phase amplitude plots, root locus, etc. Broad experience in circuit design and closed loop servo-systems.

Transistor Circuit Applications. Experience in audio frequency circuit design or servomechanisms, circuits utilizing transistors, diodes, transformers, magnetic amplifiers, etc. Familiarity with military design requirements desirable.

Electronics Packaging Engineer. 2 years' experience in the basic development of microminiature devices or design of one or more types of electronic components such as semiconductors or resistors. Experience with military hardware requirements desirable.

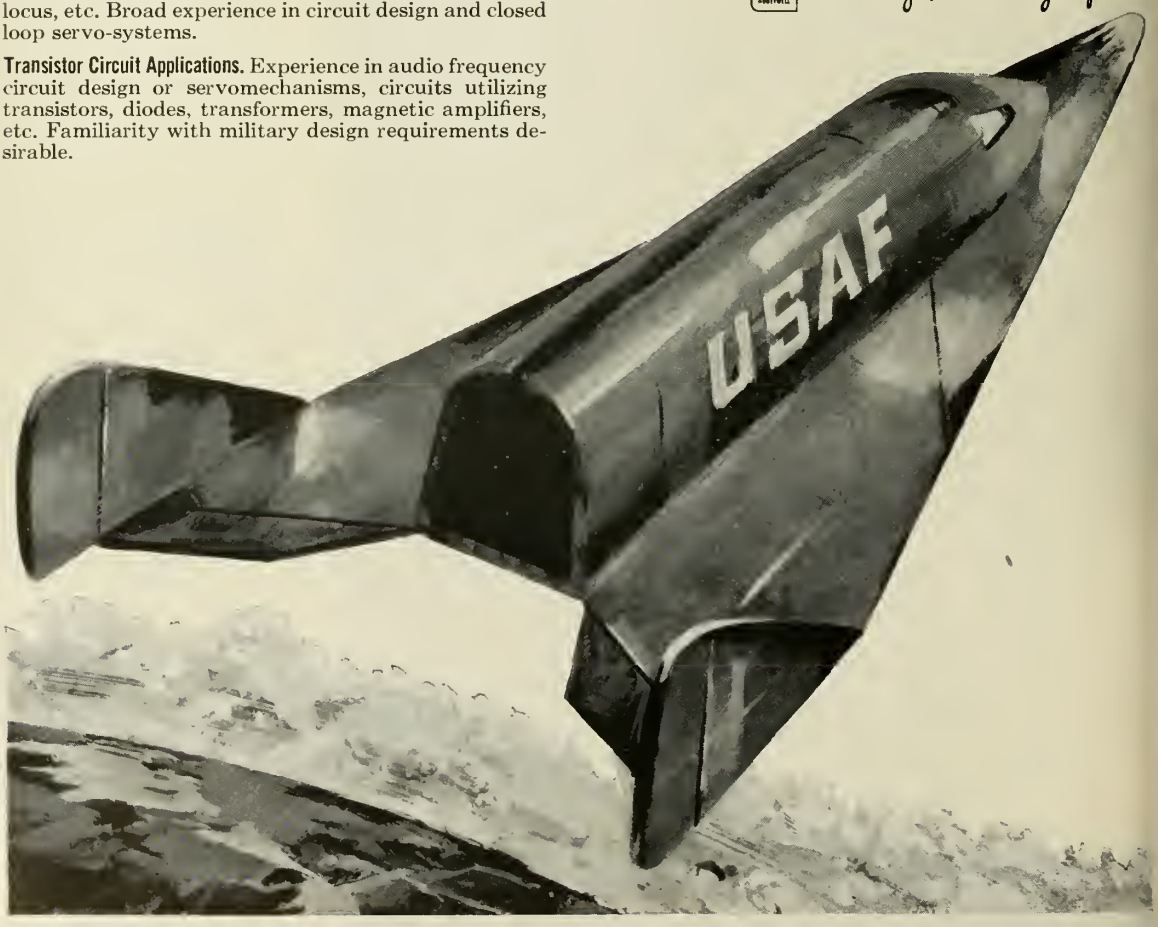
Senior Electronics Engineer to do analysis of complex servo systems and related circuitry. Must be able to translate analysis into circuitry. Four to six years' experience.

Send your resumé or request for further information to: Mr. Clyde Hansen, Technical Director, Aeronautical Division, 2602-A Ridgway Road, Minneapolis 40, Minn. All qualified applicants will receive consideration for employment without regard to race, creed, color, or national origin.

To explore professional opportunities in other Honeywell operations, coast to coast, send your application in confidence to: Mr. H. G. Eckstrom, Honeywell, Minneapolis 8, Minnesota.

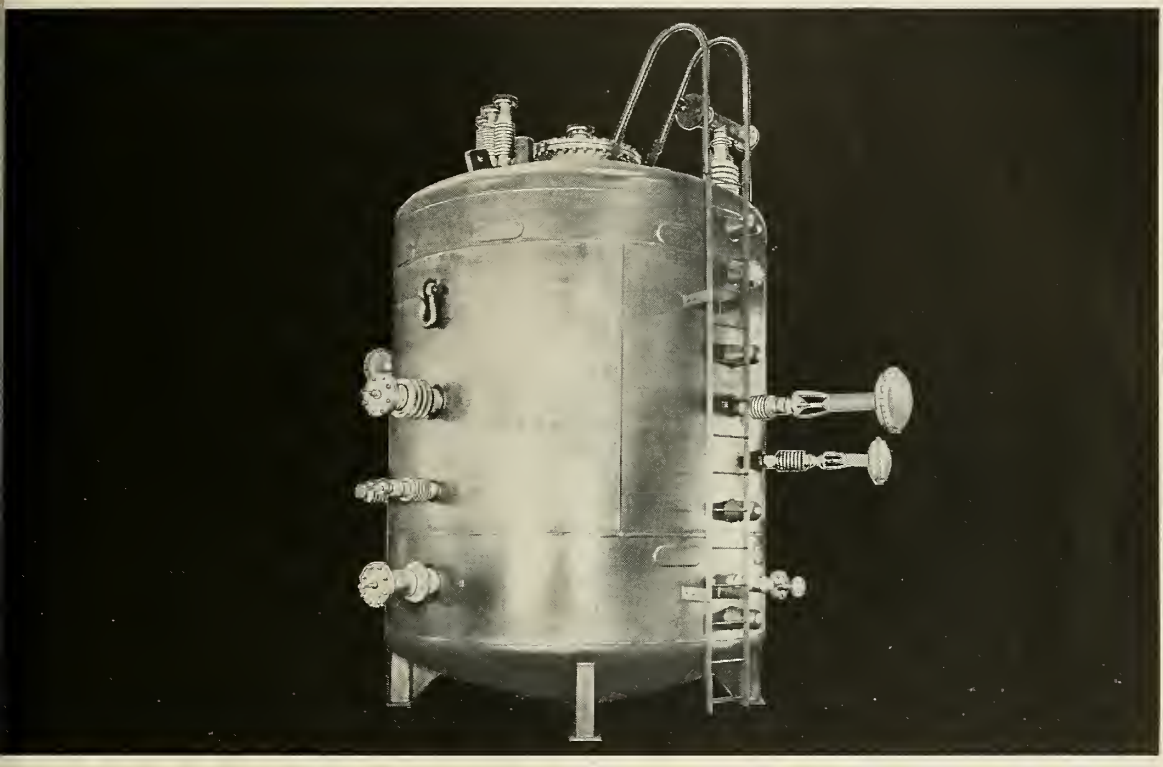
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Stearns-Roger is engaged in design, engineering and fabrication of special storage and handling facilities for LH_2. Let us develop your LH_2 equipment for capacities in the 1,000 - 30,000 gal. range.

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Major breakthrough for missile secondary injection guidance systems

This AiResearch ultra-high temperature shutoff valve has been tested at 6000°F. Its development makes possible the use of secondary injection thrust vector control for greater simplicity and reliability.

This high temperature capability is an extension of previous AiResearch valve and controls experience in the —423 to 2000°F range, and further demonstrates over-all capability in the design of complete missile and ground support systems.

An inline poppet valve of extremely clean design has been produced to handle the high speed flow of hot, contaminated gas ducted from the combustion chamber to the exhaust nozzle. This design will: (1) keep lodging of contaminants to a minimum; (2) reduce turbulence and uneven wear; and (3) permit only a small pressure drop across the valve at maximum flow.

Growth into high temperature ranges can be accomplished by changes in material without changes in the basic valve design. The extreme compactness and light weight of the valve make it ideally suited for installation in the isentropic spike of a plug nozzle.

• *Please direct inquiries to Control Systems Project, Phoenix Division*

THE GARRETT CORPORATION

AiResearch Manufacturing Divisions

Los Angeles 45, California • Phoenix, Arizona

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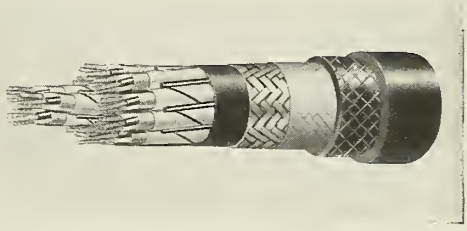
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3 Ways General Electric Helps You...

Meet Multiconductor Cable Applications for ELECTRONIC EQUIPMENT AND SYSTEMS

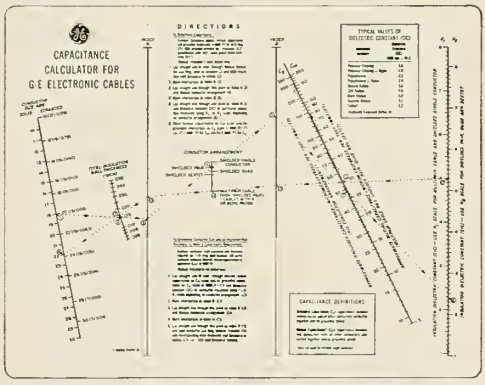
1 COMPREHENSIVE CABLE DESIGNS

General Electric can furnish the custom-designed electronic multiconductor cable you need . . . in a variety of constructions and combinations of thermoplastic, thermosetting, and Teflon insulations and jackets. G-E engineers can design cable to meet Government specifications, customer specifications, or a particular application. This design capability results from years of experience in systems engineering in radar, missiles, data processing, and other electronic applications, as well as in wire and cable.



2 TIME-SAVING CAPACITANCE CALCULATOR

General Electric's new, easy-to-use Capacitance Calculator will save you time in estimating cable capacitance or conductor size and/or insulation wall thickness to meet capacitance requirements. The calculator is made of laminated acetate for long wear, and comes complete with see-through plastic ruler.



3 EXPERT APPLICATION ASSISTANCE

General Electric Wire and Cable specialists are ready to provide complete information and show you samples of many types of G-E multiconductor cables. They are also available to help with technical assistance in cable application or design.

For your free G-E Capacitance Calculator and the name of the G-E Wire and Cable specialist in your area, write over your company letterhead to: General Electric Company, Wire and Cable Dept., Section 601-3, Bridgeport 2, Conn.



GENERAL ELECTRIC

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...key to life

Water means power . . . water means raw materials . . . water means the life of the maritime nations. Still—man is ignorant of the mysteries of the oceans . . . he is only beginning to search the depths.

General Motors Defense Systems Division is vitally interested in all ocean phenomena. For example, new nuclear submarines and their cargoes of ballistic missiles constitute one of America's most effective deterrents against attack. Water—and the *control* of water—is vital to national defense.

Scientists and engineers in the laboratories of the Defense Systems Division are also hard at work in land, aero-space, astrophysics, biological sciences, oceanography, nucleonics, and basic research projects.

DSD is dedicated to serving the Defense Department and other government agencies, in cooperation with many different branches of industry and scientific groups, in fields of fundamental research and engineering through the coordination of knowledge, abilities, ideas and hard work.

General Motors is proud to contribute, through the growing Defense Systems Division, to the strength of America and human progress. Top-level scientists and engineers in all of these specialized fields will find rare opportunities and challenging assignments in this fast-growing organization.

DEFENSE SYSTEMS DIVISION, GENERAL MOTORS CORPORATION, WARREN, MICHIGAN AND SANTA BARBARA, CALIFORNIA

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PROWESS IN SPACE AND AIRCRAFT was demonstrated in Soviet Air Show by helicopter carrying replica of Vostok.

J.S. Stands Pat on Defense Strategy

dministration indicates it is onsidering only short-term hanges in face of Red boost f perhaps $13 billion

by James Baar

THE ADMINISTRATION and a umber of leading congressmen are split ver a White House decision to stand at on plans for the nation's strategic orces despite new evidence of growing oviet power.

Meantime, some close observers of oviet affairs said the announced Soviet lan to increase military spending $3.5 illion may tell only part of the story. stimates put the actual figure as high s $13 to $15 billion.

The sharp disagreement between the dministration and Democrats in both ne Senate and House became apparent fter the Defense Department made lear:

—Its announced "third review" of ne nation's military posture as supported by the FY '62 defense budget nvolves for the most part only the mergency strengthening of conventional forces over the next four to six months.

—The Administration regards the nation's present strategic striking forces and the currently planned build up of them as sufficient. No need for new increases in the FY '62 budget for missiles and bombers is seen.

Soviet Premier Nikita Khrushchev brought on the "third review" by topping his menacing moves over Berlin with the announcement that Russia would pump another 3 billion rubles into its defense budget and halt planned reductions in the size of its military forces.

Khrushchev gave additional punch to his statements the next day by publicly reviewing at least 11 new military aircraft never before displayed. The planes included supersonic jet bombers and missile-packing jet interceptors. The implication clearly was that Soviet interest in manned jet aircraft was not as moribund as Khrushchev had previously indicated.

• **Re-examination**—Defense Secretary Robert McNamara countered the Russian moves after a hurried meeting with President Kennedy and Secretary of State Dean Rusk. McNamara said in a statement issued by the Pentagon July 10:

". . . The fact that the Soviet Union proposes to increase its military spending cannot be overlooked. The simplest precaution calls for still another examination of our defense posture.

"Currently we are strong—if not stronger—than any potential aggressor. But in the face of the inescapable realities that confront us, such as threats to dispossess us of our rightful presence in Berlin, we can do no less than reexamine our needs. This we are doing."

McNamara's statement was widely taken in Congress to mean that the third review of the nation's overall defense posture since the Kennedy Administration assumed office in January was under way. Some congressmen assumed the Pentagon was reviewing early a number of critical questions affecting big missiles and bombers—questions that must be resolved in the coming months.

Among the programs that will be affected by these decisions will be the fixed-base and mobile *Minutemen, Polaris, Nike-Zeus,* the B-70 Mach-3 bomber and the B-52 and B-58 production lines.

Some congressmen talked in terms of boosting the FY '62 defense budget another $1 billion to $2 billion. Acting Chairman A. Willis Robertson (D-Va.)



PRE-AIR SHOW photo in Red Star shows "pursuit" plane with air-to-air rockets preparing to take part in display. At least 11 new aircraft were demonstrated.

of the Senate Defense Appropriations Subcommittee said his committee would delay action on the defense appropriation bills while the Pentagon readied new recommendations.

• **Short-range only**—Then, within 24 hours, Deputy Defense Secretary Roswell Gilpatric disclosed that the Pentagon review was not a new overall study at all. He told a press conference that the review was directed only at measures that can be taken within the next few months to strengthen U.S. conventional forces "before the critical stage is reached in the German situation."

Before he spoke the military services had been ordered to make a two-week study of such matters as the possible calling up of reserve units, the current production rate of conventional ammunition and the cost of increasing aviation fuel stocks.

Either a "misunderstanding" or an overnight switch had occurred.

Gilpatric said the possibility of slowing down the current removal of B-47 bombers from SAC and a possible increase in the number of bombers on airborne alert were being considered. But he said no long-range matters were involved in the review.

"We feel that as of the moment our (strategic) posture is strong," he said. "We do not need to take new measures."

He bypassed explaining how the announced increase in the Soviet defense budget affected Communist military strength over the next few months. He also insisted that the disclosure of new Soviet jet aircraft was not a surprise and was not involved in bringing on the review.

In general, he expressed no alarm at either the Soviet budget increases or the Soviet bombers. On the contrary, he expressed some doubt as to whether the increases were anything more than propaganda.

• **Restive Lawmakers**—Congress showed more alarm.

Three Democratic senators—Clair Engle (Calif.), Howard Cannon (Nev.) and Stuart Symington (Mo.)—called for acceleration of the B-70 R&D program and increased bomber procurement. All urged that the Administration change its plans to freeze the approximately half-billion added to the FY '62 appropriations bill by the House for bombers.

Symington complained that U.S. military strategists have been cancelling fighter programs while the Russians have been developing new models. And he added: "If we do not go forward with the B-70, we will be abandoning the field in which the Russians have demonstrated they have been concentrating for some time."

In both the Senate and House, other congressmen made clear that they were worried by the Soviet disclosures and budget increases. A number felt the Administration was putting off for six months decisions that should be made now.

One of these being stressed particularly is the procurement of long-lead-time parts of *Polaris* submarines beyond the 29 ships already planned by the Administration. Failure to begin work on these parts this fall will result in a month-for-month slippage on every ship beyond the 29th.

Another pending decision being stressed is the initiation of construction of fixed *Minuteman* bases beyond the 12 squadrons now planned and the reinstatement of the mobile *Minuteman* as a currently funded program.

Failure to act on the fixed *Minuteman* this fall will mean the steady loss of the potential gain from the expansion of *Minuteman* production facilities. The mobile *Minuteman* already is slipping on about a month-for-month basis.

• **Invisible buildup**—The full impact of the announced increase in the Soviet defense budget has yet to be determined. However, if the increase is carried out, it is certain that the impact will be considerable.

For the last five years the Russians have officially earmarked between 9 and 10 billion new rubles a year for their Armed Forces—between about $10 and $11 billion according to the official exchange rate. The addition of 3 billion rubles is the first admitted increase.

But, in making U.S.-Soviet budgetary comparisons, many experts believe that the armed services item can be considered to account for only about 25% of the total Soviet military budget. The bulk of the Soviet military budget is scattered in other accounts, either directly or indirectly. Total Soviet military spending is generally estimated at about $40 to $45 billion.

Therefore, the 3-billion ruble increase could well be merely the visible portion of a far larger boost in military spending. The total figure could well run as high as $15 billion.

Among other things, such increases could well mean the Russians are beginning much more rapid deployment of long-range missiles and large-scale production of nuclear-powered submarines.

It was in the face of these possible developments that Gilpatric said the Administration saw no need at this time for the consideration of new overall increases. ⌗

Defense Ad Ban Fought In Senate

THE SENATE Defense Appropriations Subcommittee is considering arguments in favor of dropping a controversial amendment to the House-passed FY '62 defense bill which would bar defense advertising at an allowable contract cost.

The bill is expected to be reported to the Senate in about two weeks. There are indications that, if not eliminated altogether, the amendment will be relaxed to permit defense contractors to charge off advertising for new employes, scarce materials and the disposing of surplus materials.

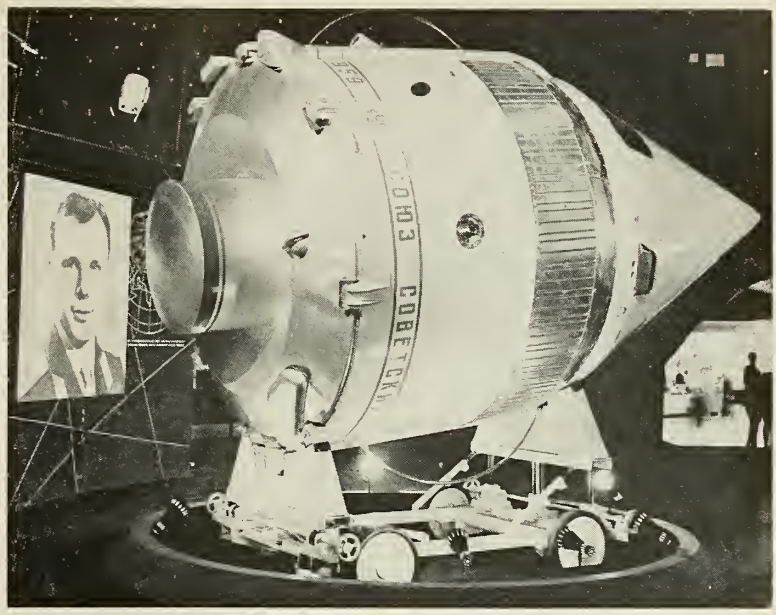
Only one witness, Sen. Howard Cannon (D-Nev.), who had charged in a Senate speech that the Federal Government was paying $500 million a year directly or indirectly in defense advertising costs, appeared in favor of the amendment at a hearing last week. Declaring that trade and technical publications "perform a worthwhile contribution," Cannon said he thought if the amendment were adopted these journals would "continue to exist based on their merit and their editorial excellence rather than on subsidy." Cannon opposed advertising which merely promotes a company's name.

Publishing and advertising witnesses who appeared in opposition said the exchange of new technical information would be impeded, thereby hurting the national defense effort, because defense industry publications would be "hamstrung by dwindling income."

Louis J. Perrottet, vice chairman for legislation of National Business Publications Inc., said DOD estimated the actual amount spent on advertising at $5-10 million. Perrottet, whose organization is comprised of 210 trade, technical, scientific and industrial publications, urged the subcommittee to consider clarification of procurement rules through a separate bill defining the "legitimate scope of advertising."

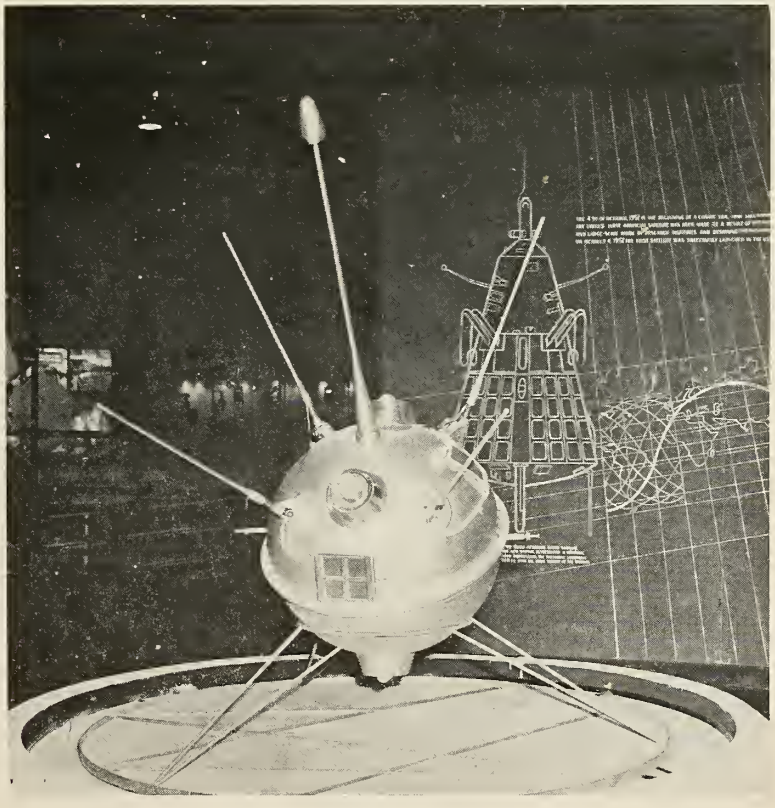
He said there were "popular misconceptions, misinformation and incorrect publicity regarding the nature of advertising for which the government is reimbursing contractors, adding it was a "relatively small portion" of the total cost of any contract.

The Aerospace Industries Association also urged the subcommittee to revise procurement rules affecting advertising rather than take legislative action. AIA promised to "help eliminate inequities or abuses in our field." ⌗



British Get Look at Soviet Spacecraft

ALTHOUGH BILLED as a main attraction of its London Industrial Exhibition, Russia's space research exhibit turned out to be rather superficial and disappointing to those who had hoped to see the latest in Soviet spacecraft. The major interest was a replica of the Mechta lunar vehicle (above) which was unlabelled, leading many visitors to think it was Yuri Gagarin's Vostok. The Mechta payload was shown by itself (below) along with replicas of Sputniks I, II and III. Gagarin himself showed up for the opening of the exhibit and received a hero's welcome from the British. He also ate lunch with the Queen.



NASA Looks for 'Super' Boss For Apollo

Wide range of prospects is surveyed amid disagreement over qualifications; set-up of program itself is clear

by Hal Taylor



Polaris Boss Raborn

. . . the answer was no.

NASA IS PLANNING to create within itself a "super management" organization to run the multibillion-dollar lunar expedition. But the space agency is having difficulty in finding a boss for the job.

MISSILES & ROCKETS has learned that Vice Adm. William F. Raborn,, director of the Navy's *Polaris* program, was offered the top spot more or less informally. He has declined.

There is a possibility, considered remote, that the White House might ask Raborn to change his mind. This would mean leaving the Navy—and a chance to become Chief of Naval Operations. Raborn has seven years to go before retirement.

Administration officials want a man of Raborn's stature to head the *Apollo* program—a man who not only can manage a program of its magnitude, but who will become a super salesman in convincing the American public of the validity of sending men to the moon.

Presently, NASA Administrator James Webb is considering a list of top space scientists and management men in NASA, the military and industry. They include Dr. Wernher von Braun, head of NASA's Marshall Space Flight Center; Robert B. Gilruth, chief of NASA's Space Task Group; James R. Dempsey, president of General Dynamics Astronautics; Gen. Bernard A. Schriever, head of the Air Force's Systems Command; and retired Maj. Gen. John B. Medaris, president of the Lionel Corp.

Sentiment appears to be running against choosing someone from NASA's ranks, Gilruth for example, on grounds he would not be well enough known. As with Raborn, there is a question of availability of several men on Webb's list.

Even when Webb arrives at a choice of the "right type for the job," there will still be conflicts to be resolved before the right type thinks the job is right for him.

• **To be Czar?**—One relates to just how much power he would have. A White House official indicates that Project *Apollo* head should be some sort of a czar who would report only to Mr. Webb. NASA officials take the stand that there is no need for a czar. As one put it, "what we need is a man who can command the loyalty and cooperation of a lot of diverse people." He said that the present NASA view is that the man in charge of the lunar program should be responsible to Webb, Dr. Hugh L. Dryden, Deputy Administrator, and Dr. Robert C. Seamans, Jr., Associate Administrator.

Another question mark is just how high a priority the program will ge from the White House. Will Projec *Apollo* be able to command the personnel and the materials it needs—or wil certain defense requirements come first'.

• **Structure Set**—While a final decision on the top manager of the program will not be made for some time NASA thinking on the type of management structure seems to be pretty wel advanced.

Current plans in the agency indicate that the Project *Apollo* setup will include:

—NASA's Space Task Group, presently based at Langley Field, Va., to be responsible for the development of the spacecraft needed to carry three men to the moon and back. In addition, it will direct the research necessary to solve such problems as solar flare radiation, and the mystery surrounding the surface of the moon.

—Marshall Space Flight Center in Huntsville, Ala., to be responsible for the development of the booster needed for lunar exploration. This will include the preparation of specifications for the Air Force's solid-propellant booster which will compete with a NASA-developed liquid booster for the role as the first stage of *Nova*, the lunar vehicle. Once a decision has been made, the center will have to see that the vehicle is ready for the first attempt to orbit the spacecraft which is now scheduled for 1965.

—Towering over both will be a management superstructure responsible for the allocation of funds, priorities, and the job of making sure that all the various segments come together at the right time to insure a successful program.

The task facing the *Apollo* head and the management structure is an immense one.

NASA estimates that getting a man to the moon and back will cost some $20 billion over the next ten years. The space agency has requested and probably will get $1.7 billion for the current fiscal year, including the additional $549 million requested by President Kennedy for the stepped-up space program.

In fiscal 1963, the NASA budget will approach and perhaps even surpass $3 billion.

The cost of the program is only part of the story. Just as awesome is its complexity.

A study prepared by a private group for NASA estimates that the *Apollo* management will have some 1000 major separate tasks to perform, initiate, check, develop and delegate. These tasks will range from a final decision as to the type of booster the *Nova*

hicle will use to the solution of all e technical problems that a man on e moon may meet, including the uestion of whether man will be able expose himself to "weightlessness" r as long as a week.

• **Calling on PERT**—It is expected at the management superstructure ill utilize the *Polaris* management con- pt "PERT"—Program Evaluation and eview Techniques.

PERT involves the use of computers insure that all segments of the pro- am are proceeding and will be com- eted on schedule.

NASA officials indicate that there e few alternatives from their present anagement concept. One possibility ould be a non-profit captive space chnology corporation similar to Aero- ace Corporation, which was set up the Air Force to perform research id development work.

NASA officials are not yet sure here the *Apollo* management will be cated, but said that the chances are od that it will be set up in Wash- gton. There is a possibility, however, at it might hang its hat, along with ASA's Space Task Group at the pro- sed $60-million Space Research Lab hich the agency wants to build. Re- rts indicate that the lab will be built Houston, Tex., but other sites have so been mentioned.

• **Key conference**—While many de- sions on Project *Apollo* are still to e made, NASA will take a giant step rward in the program this week when it holds a joint industry-government conference on *Apollo*. Some 1000 representatives from 360 space industry firms are expected to attend.

Information supplied to industry representatives attending the conference is classified, but NASA said that its primary purpose will be to acquaint industry with the research the government has already done. Three firms, Martin, Convair and GE, will also present feasibility studies which they have conducted on the program.

According to NASA, the conference agenda will include:

July 18—Presentations on the *Apollo* Space vehicle system, *Apollo* mission profiles, navigation, guidance, and controls, and spacecraft propulsion.

July 19—Sessions on space environment, heating, onboard systems, landing systems and crew participation.

July 20—Description of design and operational aspects of Project *Mercury* pertinent to Project *Apollo*.

NASA expects to present its specifications for the *Apollo* spacecraft at a bidders conference in late July or early August. The prime contract will be awarded early in 1962. ⌗

'Liberty Bell' Mercury Shot Due

THE UNITED STATES is scheduled to attempt its second manned space flight on July 18, using an advanced version of the Mercury Redstone spacecraft nicknamed the "Liberty Bell."

The new shot, if successful, will spark a sharp increase in Project Mercury activity. Slated to follow sometime next month is the third manned flight. Coming up in September are two scheduled attempts to orbit a Mercury spacecraft—one unmanned and the other carrying a monkey.

While NASA has said nothing officially, America's second astronaut is expected to be Virgil L. Grissom. The backup pilot would then be John H. Glenn, Jr.

The second flight—to be made, like the first, from Cape Canaverel—will almost duplicate Project Mercury's first manned journey into space by Alan Shepard on May 5.

The "Liberty Bell" will be quite similar to the earlier Freedom 7 craft. It, too, will weigh about two tons at liftoff, measure six ft. across its blunt bottom, and stand nine ft. high. It will also be fitted out with a 16-ft. escape tower, its titanium pressure cabin housed in a "shingled" skin of temperature-resistant alloy.

However, there will also be changes from the first flight and first spacecraft.

A new launch angle will be used to create a flight trajectory with approximately one mile higher altitude and three miles shorter range than were programed for the Shepard flight. The astronaut will also have fewer tasks to perform, and more time to look out of a new, enlarged "pilot observation" window 19 inches high, 11 inches across its base and 7½ inches across its top.

Air Defense Gets Space Spotting System

A SYSTEM to provide round-the- ock electronic cataloguing of all man- ade objects in space has been installed the headquarters of the North Ameri- an Defense Command in Colorado prings, Colo.

The Space Detection and Tracking ystem — nicknamed SPADATS — will rovide the NORAD commander with reliable, up-to-date means of evaluat- g the threat posed by an unidentified bject.

• **Computer heart**—As part of PADATS, Air Force- and Navy-oper- ed sensors feed information into an lectronic data processing system lo- ated in the NORAD Combat Opera- ons Center. The computer—a Philco eneral-purpose, asynchronous machine -analyzes the inputs, performs orbital alculations and comparisons and cata- gues the data. It then transfers the ight prediction back to the sensor sta- ons so that they can anticipate the next ppearance of the space object in their sector.

The computer also determines any changes in the flight of satellites or space vehicles, including the decay orbits of vehicles.

• **Realignment**—As a result of a realignment of the military space detection and tracking functions in November, 1960, NORAD assumed control of the "space track function."

This includes SPASUR—Space Surveillance Detection Net—which was developed by the Navy to discover "dark" or non-radiating satellites functioning across the southern U.S., and SPACETRACK—National Space Surveillance Control Center—which previously had received, analyzed and catalogued the orbital data received from SPASUR and other sources.

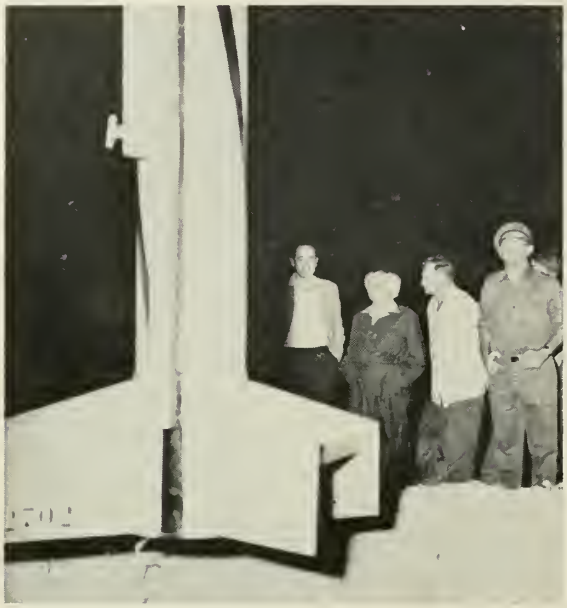
• **System functioning**—Using radar, radiometric and optometric techniques to obtain a "fix" on a man-made object in space, tracking stations throughout the world detect and obtain orbital parameters on a satellite or space vehicle. This information is transmitted by teletype to the SPADATS center at NORAD headquarters.

The high-speed computer accepts and digests all these inputs and, utilizing its pre-programed memory, sorts, categorizes and places into inventory the data concerning a particular vehicle. Upon command, or at pre-determined intervals, the computer prints out a summary of the information gathered on orbiting vehicles. The system can also be used to predict the location of a particular space vehicle at some future time.

Finally, the computer advises the sensors of anticipated locations of new orbital passes and digests other tracking data against which new readings by sensor stations can be matched.

SPADATS is manned by technicians from the 1st Aerospace Squadron, a component unit of the USAF Air Defense Command. ⌗

A Missile Race in the Middle East?





LEFT: *Near launching point of Shavit II are (left to right) Shimon Peres, Israeli Deputy Minister of Defense; Prime Minister and Minister of Defense David Ben-Gurion; Meir Mardor, Director of Development, Ministry of Defense; and Maj. Gen Zvi Zur, Chief of Staff of Israel Defense forces.* **RIGHT:** *The rocket in flight. Photos from Strategic.*

(Special to MISSILES AND ROCKETS)

TEL AVIV—Israel's Defense Ministry is believed preparing to launch two more solid-fueled rockets this month in a developmental series apparently aimed at producing a tactical missile.

One of the shots is expected to be a duplicate of the *Shavit II* (Comet) fired to a height of about 50 miles July 5 from a secret launching site on the shores of the Mediterranean. The other reportedly will be a larger rocket. *Shavit II* had either two or three stages.

Only superficially disguised as a "weather research rocket" (it released a charge of sodium at apogee but did not carry other instrumentation), the *Shavit* firing set off a tremor in the delicate Middle East power balance.

The United Arab Republic, it was disclosed in Washington, is negotiating with Zimney Corp., Monrovia, Calif., for the purchase of sounding rockets it says it wants to use to conduct its own meteorological research program—an explanation quickly denounced in Congress as an attempt to obtain information to build a military rocket.

In a telegram to Secretary of State Rusk, Rep. William Fitts Ryan (D-N.Y.) asked that an export license granted to Zimney be suspended. Claiming the UAR would use the rockets to analyze their components and fuel, Ryan said:

"I am informed that the UAR does not have a proper scientific program for the use of these rockets. In my opinion rockets will be used in connection with the July 23 celebration of (UAR President Gamal Abdel) Nasser's rise to power for propaagnda purposes." However, it was believed the rockets were shipped July 3.

• **Defense problems**—Israel Deputy Defense Minister Shimon Peres admitted candidly that the rocket program being conducted in great secrecy by Israeli scientists is being given priority because of "grave defense problems."

Manufactured by the government Military Industries, which produces propellant for air-to-air rockets, bazookas and explosives for ammunition, the *Shavit II* weighed more than 550 lbs. Well informed sources said it will have a range of about 70 miles—about the same as a U.S. *Sergeant* tactical missile. Speed is put at 4921 ft./sec. Cost—exclusive of R&D—about $25,000.

Development of the rocket is under the Research and Scientific Planning Department of the Defense Ministry's Authority for Development of Arms and Fighting Equipment. Chief of research is Dr. Ernst Bergman, also a director of the Israel Atomic Energy Committee.

Disclosure of Israel's construction of an atomic reactor several months ago has given rise to speculation that it might try to arm a rocket with a nuclear warhead as well as produce other nuclear armaments.

The formula for the propellant is said to have been devised by Israeli scientists, although names of members of the rocket team are being withheld for "security reasons." Neither was the exact length of the development program revealed. One source says "it would be correct to say that the last 12 months had been spent on most part of the project"—a rather short time without outside assistance.

It is understood, however, that some of the work was done at the Technical Institute in Haifa, whose Aeronautical Department is conducting some research for the U.S. Air Force.



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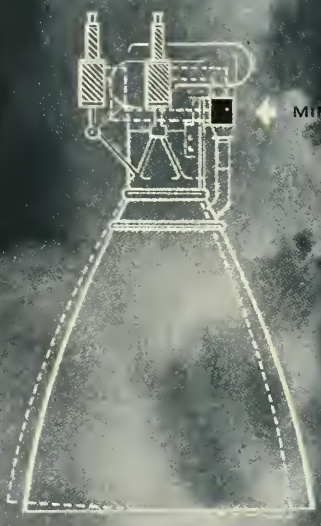
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Missiles and Rockets

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1961

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78 Typhon
85 Vego
96 Venus Probe
84 Vigilont
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95 Voyager
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94 X-15
79 Zuni



STRATEGIC MISSILES

Base-building delays slowed deployment of big U.S. strategic missiles in 1961. But this was offset somewhat by an increase in Polaris submarines.

Less than 50 Atlases were expected to be operational by the end of 1961; the first Titan squadron was slipping into 1962. To the three Polaris subs on station

ATLAS (Air Force)

MILITARY DESIGNATION: SM-65

TYPE: ICBM surface-to-surface (fixed base)

STATUS: Operational

PRIME CONTRACTOR: Convair-Astronautics Division, General Dynamics Corp.

PERFORMANCE: Range—more than 8000 n. miles. *Speed*—about 18,000 mph. *Apogee*—more than 600 n. miles.

FRAME: *System contractor*—Convair. *Length*—82.5 ft. *Diameter*—10 ft. *Launch weight*—266,000 lbs. *Material (major)*—stainless steel.

GUIDANCE: *System contractor:* GE/Burroughs; Bosch Arma. *Type*—1st four squadrons radio-inertial, last nine all inertial.

BOOSTER: *System contractor*—Rocketdyne. *Propellant*—LOX and RP-1. *Thrust*—165,000 lbs. each of two boosters.

SUSTAINER: *System contractor*—Rocketdyne. *Propellant*—LOX and kerosene. *Thrust*—60,000 lbs.

RE-ENTRY VEHICLE: *System contractor*—General Electric/Avco. *Warhead type*—nuclear.

G.S.E.: *Launcher*—Convair. *Fueling*—Arthur D. Little Co. *Handling and service*—Goodyear Aircraft. *Transport vehicles*—Goodyear Aircraft.

REMARKS: Atlases in silos beginning with squadron 8 will have reduced reaction time.

DEPLOYMENT

SQUADRONS PLANNED: 13

BASES PLANNED: 10

SQUADRON STRENGTH: 6 to 12 missiles

INITIALLY OPERATIONAL: Sept. 9, 1959 at Vandenberg AFB, Calif.

TOTAL NUMBER OF MISSILES ON LAUNCHERS: 132 (Missiles at Vandenberg also used for training)

Squadron Locations

VANDENBERG AFB, LOMPOC, CALIF. One squadron—9 missiles, 6 soft, 3 hard, non-dispersed.

WARREN AFB, CHEYENNE, WYO. Three squadrons—(1) 6 missiles, soft, non-dispersed; (2) 9 missiles, soft, semi-dispersed; (3) 9 missiles, semi-hard, dispersed.

OFFUTT AFB, OMAHA, NEB. One squadron—9 missiles, semi-dispersed, soft.

FAIRCHILD AFB, SPOKANE, WASH. One squadron—9 missiles, dispersed, semi-hard.

FORBES AFB, TOPEKA, KANS. One squadron—9 missiles, dispersed, semi-hard.

SCHILLING AFB, SALINA, KANS. One squadran—12 missiles, dispersed, hard.

LINCOLN AFB, LINCOLN, NEB. One squadron—12 missiles, dispersed, hard.

ALTUS AFB, ALTUS, OKLA. One squadron—12 missiles, dispersed, hard.

DYESS AFB, ABILENE, KANS. One squadran—12 missiles, dispersed, hard.

WALKER AFB, ROSWELL, N.M. One squadron—12 missiles, dispersed, hard.

PLATTSBURGH AFB, PLATTSBURGH, N.Y. One squadron—12 missiles, dispersed, hard.

Operational model Atlas leaves pad at Canaveral—Several squadrons are on combat status

at mid-year, however, the Navy planned to add two and possibly three for a total of 80-96 Polarises operational by 1962.

The new Kennedy Administration decided against a major increase in the ICBM program—putting the total due to be on launchers by 1965 at about 1300. Polaris is being accelerated, but no provision was made beyond the 29th boat (the Navy wants a fleet of 45); the mobile Minuteman launcher was shelved.

More Minuteman production facilities were authorized, but there was no sign that the number in silo launchers would be increased beyond the planned 600.

MINUTEMAN (Air Force)

MILITARY DESIGNATION: SM-80

TYPE: ICBM surface - to - surface (fixed base and mobile)

STATUS: R&D

MAJOR CONTRACTOR: Boeing Co.

PERFORMANCE: *Range*—5500 n. miles. *Speed*—more than 15,000 mph. *Apogee*—about 600 miles.

FRAME: *System contractor*—Boeing. *Length*—56 ft. *Diameter*—about 6 ft. *Launch weight*—64,300 lbs. *Material (major)*—steel (first two stages), titanium or plastic (third stage).

GUIDANCE: *System contractor*—Autonetics. *Type*—all inertial.

BOOSTER: *System contractor*—Thiokol. *Propellant*—solid. *Thrust*—about 160,000 lbs.

SECOND STAGE: *System contractor*—Aerojet-General. *Propellant*—solid.

THIRD STAGE: *System contractor*—Hercules Powder. *Propellant*—solid.

RE-ENTRY VEHICLE: *System contractor* — Avco. *Warhead type* — nuclear.

G.S.E.: *Launcher*—Boeing. *Handling and service*—Boeing. *Transport vehicles*—Boeing.

REMARKS: Mobile program deferred 18-24 months.

DEPLOYMENT

SQUADRONS PLANNED: 12 (fixed site)

BASES PLANNED: 4

SQUADRON STRENGTH: 50 missiles

INITIALLY OPERATIONAL: Mid-1962

TOTAL NUMBER OF MISSILES ON LAUNCHERS: 600

Squadron Locations

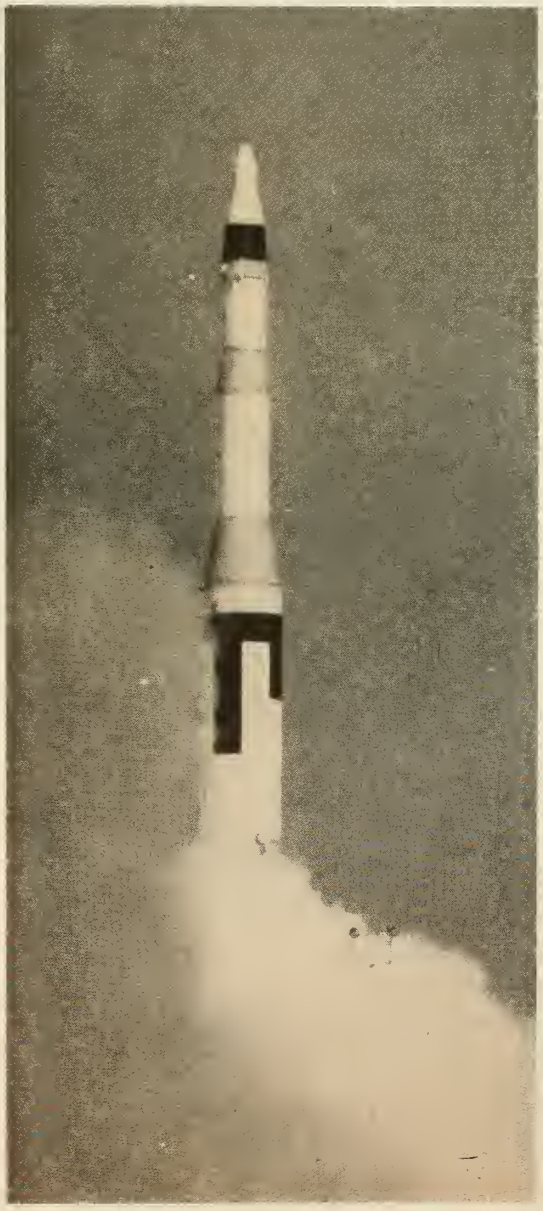
MALMSTROM AFB, MONT. Three squadrans in dispersed, hardened silas, in-sila launch.

ELLSWORTH AFB, S.D. Three squadrans in dispersed, hardened silos, in-sila launch.

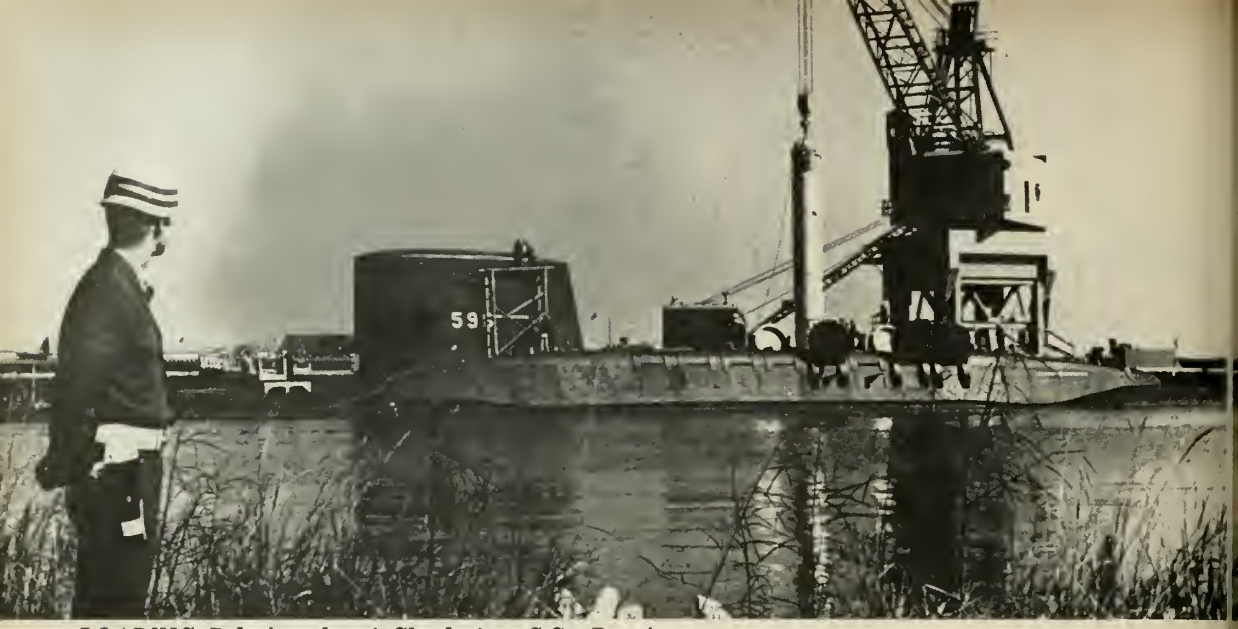
HILL AFB, UTAH. Railhead far first train-based mobile squadrans when develaped.

MINOT AFB, N.D. Three squadrans in dispersed hardened silas, in-sila launch.

WHITEMAN AFB, MO. Three squadrans in dispersed hardened silas, in-sila launch.



Successful first flight of Minuteman in early 1961. Solid-fueled ICBM is to be operational in 1962



LOADING Polaris subs at Charleston, S.C., Depot



1500-mile Polaris A-2

POLARIS (Navy)

MILITARY DESIGNATION: FBM

TYPE: Submorine or surfoce ship-lounched IRBM surfoce-to-surfoce (mobile)

STATUS: A-1 operotion; A-2 ond A-3 R&D

PRIME CONTRACTOR: Lockheed Missiles ond Spoce Division, Lockheed Aircroft Corp.

PERFORMANCE: *Ronge*—1200 n. miles (A-1), 1500 n. miles (A-2), 2500 n. miles (A-3). *Speed* — obout 8000 mph. *Apogee*—about 400 miles.

FRAME: *System controctor*—Lockheed. *Length*—28 ft. (A-1); 30.5 ft. (A-2 ond A-3). *Diometer*—4.5 ft. *Lounch weight* — 28,000 lbs. (A-1), obout 30,000 (A-2) obout 30,000, (A-3) more thon 30,000. *Moteriol (mojor)*—steel

GUIDANCE: *System controctor*—Generol Electric/MIT. Type—all inertiol.

BOOSTER: *System controctor* — Aerojet-Generol. *Propellont*—solid *Thrust*—about 100,000 lbs.

SUSTAINER: *System controctor*—Aerojet-Generol. *Propellont*—solid.

FIRE CONTROL: *System controctor* —Generol Electric.

NAVIGATION: *System controctor* — Sperry-Gyroscope / Autonetics. *Type*—inertiol (SINS).

RE-ENTRY VEHICLE: *System controctor*—Lockheed. *Worheod type* —nucleor.

G.S.E.: *Louncher*—Westinghouse. *Hondling ond service*—Westinghouse/Lockheed. *Tronsport vehicles*—Lockheed.

REMARKS: Advonced 1500 n. mile ond 2500 n. mile models under development. NATO notions moy purchose for deployment os lond-bosed NATO IRBM.

DEPLOYMENT

MISSILE - LAUNCHING NUCLEAR-POWERED SUBMARINES PLANNED BY NAVY: obout 45.

SUBMARINES AUTHORIZED PART OR WHOLE: 29.

MISSILES PER SUBMARINE: 16

INITIALLY OPERATIONAL: 1960.

TOTAL NUMBER OF MISSILES: (outhorized): 464

Polaris Submarines

GEORGE WASHINGTON 380 ft. 5600 tons commissioned 1960 Electric Boot

PATRICK HENRY 380 ft. 5600 tons commissioned 1960 Electric Boot

THEODORE ROOSEVELT 380 ft. 5600 tons commissioned 1960 More Island

ROBERT E. LEE 380 ft. 5600 tons commissioned 1960 Newport News Ship

ABRAHAM LINCOLN 380 ft. 5600 tons commissioned 1960 Portsmouth Novol

ETHAN ALLEN 410 ft. 6900 tons commissioned 1961 Electric Boot

SAM HOUSTON 410 ft. 6900 tons launching 1961 Newport News Ship

THOMAS A. EDISON 410 ft. 6900 tons launching 1961 Electric Boot

JOHN MARSHALL 410 ft. 6900 tons launching 1961 Newport News Ship

LAFAYETTE 425 ft. 7000 tons launching 1962 Electric Boat

ALEXANDER HAMILTON 425 ft. 7000 tons launching 1962 Electric Boot

THOMAS JEFFERSON 410 ft. 6900 tons launching 1962 Newport News

ANDREW JACKSON 425 ft. 7000 tons launching 1962 More Island

(Sixteen more outhorized or requested by Administrotion)

TITAN (Air Force)

MILITARY DESIGNATION. SM-68

TYPE: ICBM surface - ta - surface (fixed base).

STATUS: Titan I nearly aperatianal, Titan II R&D

PRIME CONTRACTOR: Martin Co.

PERFORMANCE: *Range*—mare than 5500 n. miles. *Speed*—17,000 mph. *Ceiling*—mare than 600 miles.

FRAME: *System cantractar*—Martin. *Length*—98 ft. (Titan I), more than 100 ft. (Titan II). *Diameter (max.)*—10 ft. *Launch weight*—220,000 lbs. *Materiol (majar)*—2014K aluminum.

GUIDANCE: *System contractor*—Bell Telephane Labaratories/Remingtan Rand UNIVAC (Titan I), A.C. Spark Plug (Titan II). *Type*—radia inertial first six squadrans; later squadrans all inertial.

BOOSTER: *System contractor*—Aerojet General. *Propellant*—LOX and RP-1 (Titan I); UDM4 and hydrazine/nitrogen tetraxide Titan II). *Thrust*—300,000 lbs. (Titan I); nearly 500,000 lbs. (Titan II).

SUSTAINER: *System contractor*—Aerajet General. *Propellant*—LOX and RP-1. *Thrust*—80,000 lbs. (Titan I); 100,000-120,000 lbs. (Titan II).

RE-ENTRY VEHICLE. *System contractor*—Avca (Titan I); G.E. (Titan II). *Warhead type*—nuclear.

G.S.E.: *Launcher*—Martin. *Fueling*—Air Products/Cambridge Carp. *Handling and service*—Martin. *Transpart vehicles*—Narth American. *Elevator*—AMF.

REMARKS: Langer range Titan II will have a starable propellant and will be launched fram its underground sila. Titan II will be deplayed with Squadran 7.

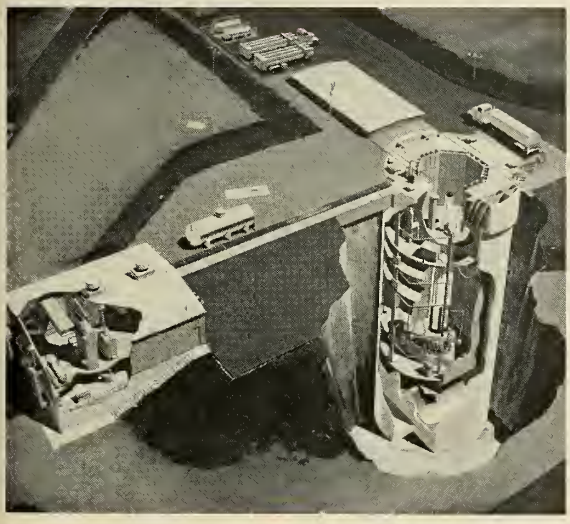


Diagram of Titan test facility

DEPLOYMENT

SQUADRONS PLANNED: 12

BASES PLANNED: 8

SQUADRON STRENGTH: 9 missiles

INITIALLY OPERATIONAL: 1961 (Titan I); 1963 (Titan II)

TOTAL NUMBER OF MISSILES ON LAUNCHERS: 108

Squadron Locations

LOWRY AFB, DENVER, COLO. Two squadrans—semi-dispersed, hard, elevated ta surface far launching.

ELLSWORTH AFB, RAPID CITY, S.D. One squadran—semi-dispersed, hard, elevated ta surface far launching.

MOUNTAIN HOME AFB, MOUNTAIN HOME, IDAHO. One squadron—semi-dispersed, hard, elevated ta surface far launching.

LARSON AFB, MOSES LAKE, WASH. One squadran—semi-dispersed, hard, elevated ta surface far launching.

BEALE AFB, MARYSVILLE, CALIF. One squadran—semi-dispersed, hard, elevated ta surface far launching.

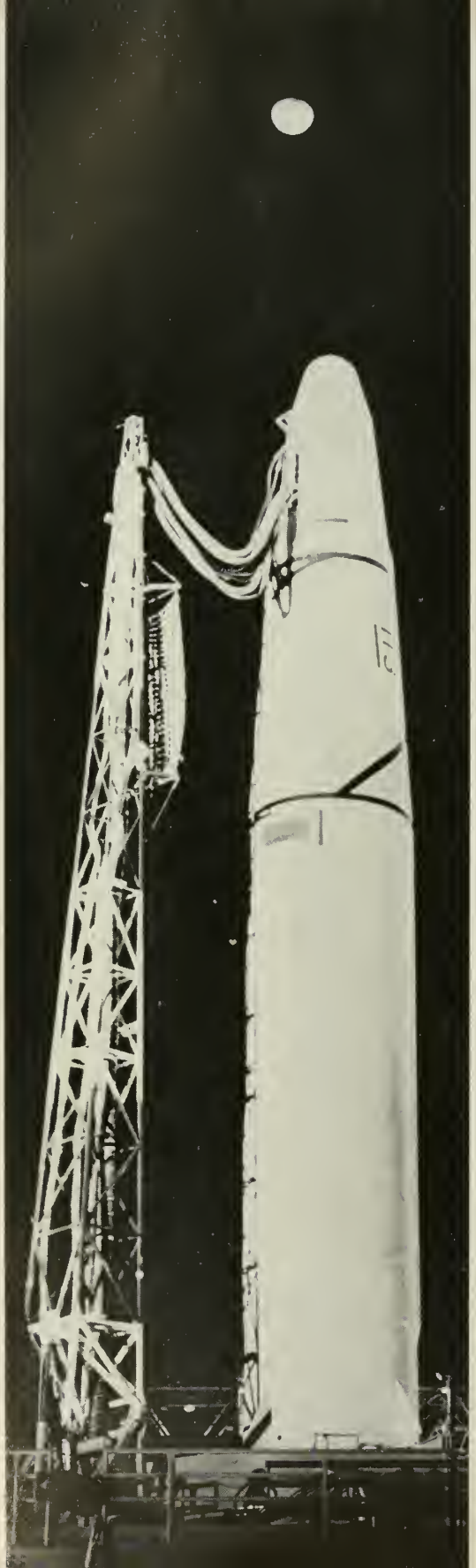
DAVIS-MONTHAN AFB, TUCSON, ARIZ. Twa Titan II squadrans—dispersed, hard, in-silo launched.

McCONNELL AFB, WICHITA, KANS. Two Titan II squadrans—dispersed, hard, in-silo launched.

LITTLE ROCK AFB, LITTLE ROCK, ARK. Two Titan II squadrans—dispersed, hard, in-sila launched.



Nearly operational Titan takes off



THOR (Air Force)

MILITARY DESIGNATION: SM-75

TYPE: IRBM surface-to-surface

STATUS: Operational

PRIME CONTRACTOR: Douglas Aircraft Co., Inc.

PERFORMANCE: *Range*—1500 n. miles. *Speed*—10,000 mph. *Apogee*—about 400 miles.

DEPLOYMENT: *Location*—Great Britain (military); Vandenberg AFB and Cape Canaveral (R&D and training). Initially operational in England—1959. *Total squadrons* — four. *Total bases* — four with 20 sites. *Squadron strength* —15 missiles. *Total missiles deployed*—60.

FRAME: *System contractor*—Douglas. *Length*—65 ft. *Diameter*—8. *Launch weight*—110,000 lbs. *Material (major)*—aluminum.

GUIDANCE: *System contractor*—A.C. Spark Plug. *Type*—all inertial.

BOOSTER: *System contractor*—Rocketdyne. *Propellant*—LOX and JP4. *Thrust*—150,000 lbs.

RE-ENTRY VEHICLE: *System contractor*—General Electric. *Warhead type*—nuclear.

G.S.E.: *Launcher*—Food Machinery. *Fueling*—Doco. *Transport vehicles*—Fruehauf.



REGULUS I

REGULUS I (Navy)

MILITARY DESIGNATION: SSM-N-8

TYPE: Air-breathing surface-to-surface (seaborne)

STATUS: Operational

PRIME CONTRACTOR: Chance Vought Corp.

PERFORMANCE: *Range*—500 n. miles. *Speed*—about 600 mph. *Ceiling*—about 40,000 ft.

DEPLOYMENT: *Location*—aboard five submarines (Growler, Barbero, Greyback, Tunny and nuclear-powered Halibut) and two cruisers (Los Angeles and Helena). *Initially operational*—1954.

FRAME: *System contractor*—Chance Vought. *Length*—34 ft. *Diameter*—4.5 ft. *Wingspan*—21 ft. *Launch weight*—14,000 lbs. *Material (major)*—aluminum.

GUIDANCE: *System contractor*—Sperry. *Type*—radio command or inertial.

BOOSTER: *System contractor*—Aerojet. *Propellant*—solid. *Number*—two. *Thrust*—33,000 lbs. each.

SUSTAINER: *System contractor*—Allison. *Engine*—J33-18 turbo-jet. *Thrust*—4600 lbs.

PAYLOAD: *Warhead type*—nuclear.

G.S.E.: *Launcher*—Fruehauf. *Fueling*—Chance Vought. *Handling and service*—Chance Vought. *Transport vehicles*—Fruehauf.

REMARKS: Last of more than 500 Regulus I's were delivered in 1958. Production terminated. Warhead considered large.

THOR

JUPITER (Air Force-Army)

MILITARY DESIGNATION: SM-78

TYPE: IRBM surfoce-to-surface (fixed base or mobile)

STATUS: Operationol

PRIME CONTRACTOR: Chrysler Corp.

PERFORMANCE: *Ronge*—1500 n. miles. *Speed*—10,000 mph. *Apogee*—380 miles.

DEPLOYMENT: *Location*—Italy ond Turkey. Initiolly operotional in Italy—1961. *Totol squodrons planned*—two in Itoly; one in Turkey. *Totol fixed boses*—three. *Squadron strength*—15 missiles. *Total missiles*—45.

FRAME: *System contractor*—Chrysler. *Length* — 58 ft. *Diameter* — 8.75 ft. *Launch weight*—105,000 lbs. *Material (majar)*—aluminum.

GUIDANCE: *System contractor*—Ford Instrument. *Type*—all inertial.

BOOSTER: *System contractor*—North American Aviotion, *Propellant*—LOX and kerosene. *Thrust*—150,000 lbs.

RE-ENTRY VEHICLE: *System contractor*—Goodyear/CTL. *Warhead type*—nucleor.

G.S.E.: *Louncher*—Chrysler. *Fueling*—Chrysler. *Handling and service*—Chrysler. *Transport vehicles*—Chrysler.

REMARKS: Jupiter was developed by the Army Ballistic Missile Agency and turned over to the Air Force for operational deployment.



REGULUS II (Navy)

MILITARY DESIGNATION: SM-N-9A

TYPE: Air-breathing surfoce-to-surface (seoborne)

STATUS: Operationol os KD2A-1 target drone.

PRIME CONTRACTOR: Chance Vought Corp.

PERFORMANCE: *Range* — more than 800 n. miles. *Speed*—more than Mach 2. *Ceiling*—more than 65,000 ft.

DEPLOYMENT: *Location*—PMR, Point Mugu, Calif., ond Eglin Test Ronge, Flo. *Initially operational:* March, 1959.

FRAME: *System contractor*—Chance Vought. *Length*—59.5 ft. *Diameter:* 50 in. *Wingspan*—20 ft. *Launch weight*—up to 30,000 lbs. *Material (major)*—aluminum.

GUIDANCE: *System contractor*—Bell. *Type*—radio command or inertial.

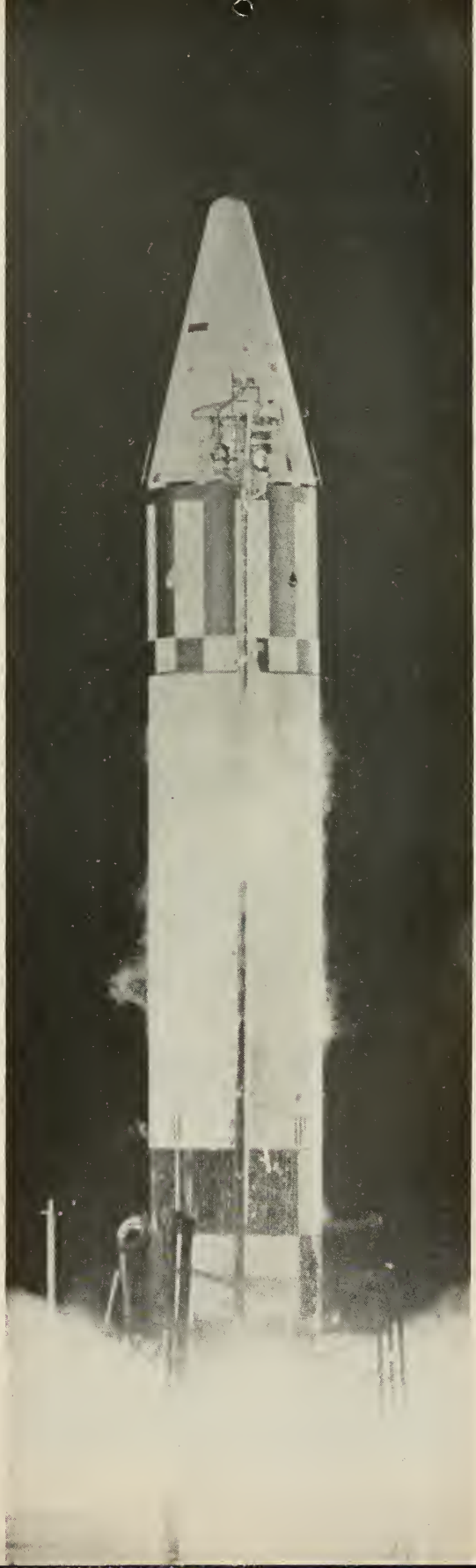
BOOSTER: *System contractor*—Aerojet and Rocketdyne. *Propellant*—solid. *Thrust*—115,000 and 130,000 lbs.

SUSTAINER: *System contractor*—General Electric. *Engine*—J-79-3 turbo-jet. *Thrust*—more than 10,000 lbs.

PAYLOAD: *Worhead type for military version*—nuclear.

G.S.E.: *Launcher*—Fruehauf. *Fueling*—Chance Vought. *Handling and service*—Chance Vought. *Transport vehicles*—Fruehauf.

REMARKS: The Navy cancelled the Regulus II weapon system in December, 1958 for budgetary reasons on grounds thot the missile had become obsolescent.



JUPITER



HOUND DOG

HOUND DOG (Air Force)

MILITARY DESIGNATION: GAM-77

TYPE: Air-breathing air-to-surface

STATUS: Operational

PRIME CONTRACTOR: North American Aviation, Inc.

PERFORMANCE: Range — more than 500 n. miles. *Speed*—about Moch 2. *Apogee*—air-breather.

DEPLOYMENT: *Locatian*—SAC B-52 boses in U.S. *Initiolly operatianal*—1960. *Total deployed missiles*—expected to exceed 400.

FRAME: *System cantractar*—North Americon. *Length*—42.5 ft. *Diameter*—28 in. *Wing spon*—12 ft. *Launch weight*—about 10,000 lbs.

GUIDANCE: *System contractor*—Autanetics. *Type*—all inertial.

POWERPLANT: *System cantractor*—Prott & Whitney. *Engine*—J-52 turbo-jet. *Thrust*—7500 lbs.

RE-ENTRY VEHICLE: *Type warheod*—nuclear.

REMARKS: Hound Dog was developed as on interim weopon for use while the Air Force is developing the far superior Skybalt.



QUAIL

QUAIL (Air Force)

MILITARY DESIGNATION: GAM-72

TYPE: Air-lounched missile ECM decoy

STATUS: Operational

PRIME CONTRACTOR: McDonnell Aircraft Corp.

PERFORMANCE: *Range*—more than 200 n. miles. *Speed*—neor sonic. *Ceiling*—more than 50,000 ft.

DEPLOYMENT: *Locatian*—SAC air boses. *Initiolly operatianal*—1960

FRAME: *System cantroctor*—McDonnell. *Length*—12.9 ft. *Wingspon*—5.4 ft. *Launch weight*—obout 1200 lbs. *Material*—aluminum and reinforced plastic.

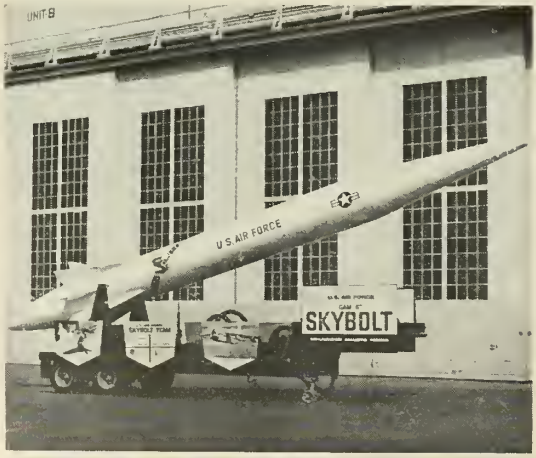
GUIDANCE: *System cantroctor*—Summers Gyro. *Type*—gyro outopilot.

POWERPLANT: *System cantractar*—Generol Electric. *Engine*—J85-7 turbo-jet. *Thrust*—2450 lbs.

PAYLOAD: *System cantractar*—Romo-Wooldridge. *Type* — electronic cauntermeosures simulation subsystems.

G.S.E.: *System contractor*—Bell Aircroft.

REMARKS: Quoil is designed to serve a dual role os a decoy for a strategic bomber ond as o vehicle ta carry ECM equipment.



SKYBOLT

SLAM (Air Force)

TYPE: Intercontinental nuclear-powered missile

STATUS: Study

PRIME CONTRACTOR: Na cantroctor announced

PERFORMANCE: Range—globol. *Speed*—supersonic. *Ceiling*—low altitude.

SUSTAINER: *System cantractar*—R&D being conducted by the Atomic Energy Commission, N.A.A. Internotional and Marquardt (Project Pluto). *Engine*—nucleor-powered ramjet.

PAYLOAD: *Warhead type*—nuclear.

REMARKS: Convair, North American and Chance Vought ore principal competitors in studies submitted to the Air Force.

SKYBOLT (Air Force)

MILITARY DESIGNATION: GAM-87A

TYPE: air-to-surfoce bollistic missile (ALBM)

STATUS: R&D

PRIME CONTRACTOR: Douglas Aircraft Co.

PERFORMANCE: Range—1000 n. miles. *Speed*—hypersonic.

DEPLOYMENT: *Locatian*—SAC oir boses. Also RAF bases in England. (Skybolts moy be launched from variety of aircroft besides bombers—particularly tankers and transports.) *Initially aperotianol*—about 1964. B-52's to corry 4 missiles; Vulcans, 2.

FRAME: *System cantractar*—Douglas.

GUIDANCE: *System cantractar*—Nortranics. *Type*—stellor-inertiol.

BOOSTER: *System contractor*—Aerajet. *Propellant*—solid.

SUSTAINER: *System cantroctar*—Aerojet. *Propellant*—solid.

RE-ENTRY VEHICLE: *System cantroctar*—Generol Electric. *Warheod type*—nucleor.

TACTICAL MISSILES



PERSHING *REDSTONE*



The U.S. and its allies are proceeding with a buildup of tactical-missile muscle that will greatly increase the firepower of the individual soldier.

Mobility continues to be a major problem—and the military is pressing industry for lighter and simpler GSE.

Even so, introduction of Sergeant and Little John—and the coming deployment of nuclear-tipped Davy Crocketts and the Pershing—will provide the infantryman with the most potent and effective artillery ever seen on a battlefield.

SURFACE-TO-SURFACE

PERSHING (Army)

TYPE: Surface-to-surface

STATUS: Late R&D

PRIME CONTRACTOR: The Martin Co.

PERFORMANCE: *Range*—350 n. miles. *Speed*—supersonic.

DEPLOYMENT: *Location*—to replace Redstone. *Initially operational:* about late 1961.

FRAME: *System contractor*—Martin. *Length*—34 ft. *Diameter*—40 in.

GUIDANCE: *System contractor*—Bendix. *Type*—inertial.

BOOSTER: *System contractor*—Thiokol. *Propellant*—solid.

SUSTAINER: *System contractor*—Thiokol. *Propellant*—solid.

PAYLOAD: *Warhead type*—nuclear.

G.S.E.: *Transporter-erector-launcher*—Thompson Rama Waaldridge. *Handling and services*—Thompson Rama Waaldridge. *Vehicles*—Food Machinery.

REMARKS: Range could be greatly increased if desired. First R&D launching Feb. 25, 1960 from Cape Canaveral, Fla.

REDSTONE (Army)

MILITARY DESIGNATION: SSM-5

TYPE: Surface-to-surface

STATUS: Operational

PRIME CONTRACTOR: Chrysler Corp.

PERFORMANCE: *Range*—200 n. miles. *Speed*—3800 mph. *Apogee*—55 miles.

DEPLOYMENT: *Location* — U.S. troops in Germany. *Initially operational*—1958.

FRAME: *System contractor*—Reynolds Metals. *Length*—70 ft. *Diameter*—5.5 ft. *Launch weight*—62,000 lbs. *Material* (major)—aluminum.

GUIDANCE: *System contractor*—Ford Instrument. *Type*—inertial.

BOOSTER: *System contractor*—North American Aviation. *Propellant*—Liquid. *Thrust*—78,000 lbs.

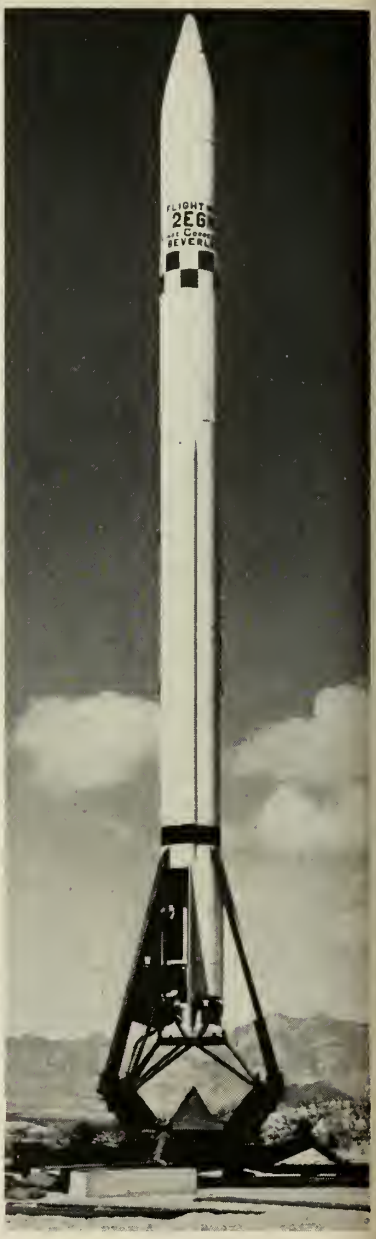
PAYLOAD: *Warhead type*—nuclear or HE.

G.S.E.: *Launcher*—Chrysler. *Fueling*—Chrysler. *Handling and service*—Chrysler. *Transport vehicles*—Chrysler.

REMARKS: To be replaced by Pershing. Redstones are being used in the Mercury program by NASA for early equipment and manned test flights.



SERGEANT



CORPORAL

SERGEANT (Army)

MILITARY DESIGNATION: SSM-A26

TYPE: Surface-to-surface

STATUS: Nearly operational

PRIME CONTRACTOR: Sperry Utah Engineering Lab.

PERFORMANCE: *Range*—85 miles. *Speed*—supersonic.

DEPLOYMENT: *Location* — to replace Corporal. *Initially operational*—1961.

FRAME: *System contractor*—Sperry. *Length*—35 ft. *Diameter*—31 in. *Launch weight*—10,000 lbs. *Material (major)*—steel and aluminum.

GUIDANCE: *System contractor*—Sperry. *Type*—inertial.

BOOSTER: *System contractor*—Sperry. *Propellant*—solid. *Thrust*—about 55,000 lbs.

PAYLOAD: *Warhead type* — nuclear or HE.

G.S.E.: *Launcher*—Temco Aircraft. *Fueling* — Thiokol. *Handling and service* — Sperry. *Transport vehicles*—Fruehouf.

CORPORAL (Army)

MILITARY DESIGNATION: M-2

TYPE: Surface-to-surface

STATUS: Operational

PRIME CONTRACTOR: Firestone Tire & Rubber Co./Gilfillan Bros.

PERFORMANCE: *Range*—75 miles. *Speed*—Mach 3.

DEPLOYMENT: *Location*—U.S. troops in Europe. *Battalion strength* — two launchers; two batteries (one firing, the other service). *Initially operational*—late 1953.

FRAME: *System contractor*—Firestone. *Length*—45 ft. *Diameter*—30 in. *Launch weight*—11,000 lbs. *Material (major)*—steel.

GUIDANCE: *System contractor*—Gilfillon. *Type*—preset and command.

BOOSTER: *System contractor*—Ryan. *Propellant*—nitric acid and aniline.

PAYLOAD: *Warhead type* — nuclear or HE.

G.S.E.: *Launcher*—Firestone. *Fueling* — Firestone. *Handling and service*—Firestone.

REMARKS: To be replaced by the solid-propelled Sergeant.

LITTLE JOHN (Army)

MILITARY DESIGNATION: M-51

TYPE: Surface-to-surface

STATUS: Operational

PRIME CONTRACTOR: Emerson Electric Co.

PERFORMANCE: *Range*—10 miles. *Speed*—supersonic.

DEPLOYMENT: *Location* — missile in hands of training units in the United States. *Initially operational*—1960. *Battalion strength*—four launchers.

FRAME: *System contractor* — Emerson Electric. *Length*—14 ft. 5 in. *Diameter*—12.5 in. *Launch weight*—780 lbs. *Material (major)*—steel and aluminum.

GUIDANCE: *Type*—free-flight ballistic missile.

BOOSTER: *System contractor* — Army Ordnance Missile Command/Hercules Powder. *Propellant* — solid.

PAYLOAD: *Warhead type* — nuclear or HE.

G.S.E.: *Launcher* — Rock Island Arsenal.

REMARKS: A highly mobile and easily airlifted missile.



LITTLE JOHN



HONEST JOHN

HONEST JOHN (Army)

MILITARY DESIGNATION: M-31

TYPE: Surface-to-surface

STATUS: Operational

PRIME CONTRACTOR: Douglas Aircraft Co./Emerson Electric

PERFORMANCE: *Range*—12 miles. *Speed*—Mach 1.7.

DEPLOYMENT: *Location*—U.S. forces in continental United States, Europe and the Far East. Also in the hands of U.S. NATO allies. *Initially operational* — late 1953. *Battalion strength*—four launchers.

FRAME: *System contractor*—Douglas/Emerson. *Length*—27 ft. *Diameter*—30 in. *Launch weight*—5800 lbs. *Material (major)*—steel.

GUIDANCE: *Type*—free-flight ballistic missile.

BOOSTER: *System contractor*—Hercules Powder. *Propellant* — solid.

SPIN ROCKETS: *System contractor*—Thiokol. *Propellant*—solid.

PAYLOAD: *Warhead type* — nuclear or HE.

G.S.E.: *Launcher* — Rock Island Arsenal.

REMARKS: Douglas is producing an Improved Honest John made of aluminum with a solid booster (XM-50). The improved version has a range of more than 12 miles, weighs 1000 lbs. less and is three inches shorter.

DAVY CROCKETT (Army)

MILITARY DESIGNATION: XM-388

TYPE: Surface-to-surface

STATUS: Nearly operational

PRIME CONTRACTOR: Rock Island, Ill., Arsenal

PERFORMANCE: Launched from either two tube-shaped launchers (XM-28 and XM-29) of varying size for different ranges. Range is relatively short.

DEPLOYMENT: *Location*—U.S. troops overseas and in continental United States; also NATO allies. *Initially operational*—1962.

BOOSTER: *Propellant*—solid.

PAYLOAD: *Warhead type* — nuclear (fractional yield).

REMARKS: Smaller launcher can be carried by two men. Crockett is inserted into its launcher in the same fashion as a rifle grenade. The warhead is larger than the tube.



DAVY CROCKETT

MISSILE A (Army)

TYPE: Surface-to-surface

STATUS: R&D

PRIME CONTRACTOR: None announced

PERFORMANCE: *Range* — about 10-20 miles.

FRAME: *Launch weight* — under 500 lbs.

REMARKS: The Army Rocket and Guided Missile Agency at Huntsville, Ala., is acting as systems manager for a series of components that have been under development.

MACE



MATADOR

MACE (Air Force)

MILITARY DESIGNATION: TM-76A and TM-76B

TYPE: Air-breathing surface-to-surface

STATUS: TM-76A operational. TM-76B flight-testing.

PRIME CONTRACTOR: The Martin Co.

PERFORMANCE: *Range*—*(A)* more than 650 n. miles. *(B)* more than 1200 n. miles. *Speed*—*(A)* more than 650 mph. *(B)* some but supersonic in terminal dive. *Ceiling*—more than 40,000 ft.

DEPLOYMENT: *Location*—*(A)* U.S. troops in West Germany. *Initially operational*—*(A)* 1960. *Total divisions*—at least two. *Divisional strength*—about 50. (B) to be deployed on Okinawa.

FRAME: *System contractor*—Martin. *Length*—44 ft. *Diameter*—54 in. *Wingspan*—22.9 ft. *Launch weight*—15,500 lbs. *Material (major)*—aluminum and magnesium

GUIDANCE: *System contractor*—*(A)* Goodyear. *(B)* A.C. Spark Plug. *Type (A)*—ATRAN map-matching. *(B)* inertial.

BOOSTER: *System contractor*—Thiokol. *Propellant*—solid (JATO). *Thrust*—100,000 lbs.

SUSTAINER: *System contractor*—Allison. *Engine*—J-33-41. *Thrust*—5200 lbs.

G.S.E.: *Launcher*—*(A)* Goodyear. *(B)* Martin. *Fueling*—Martin. *Handling and service*—*(A)* Goodyear/Martin/Four Wheel Drive Auto Co. *(B)* Martin, A.C. Spark Plug. *Transport vehicles*—*(A)* Four Wheel Drive. *(B)* Martin.

MATADOR (Air Force)

MILITARY DESIGNATION: TM-61C

TYPE: Air-breathing surface-to-surface

STATUS: Operational

PRIME CONTRACTOR: The Martin Co.

PERFORMANCE: *Range*—500 n. miles. *Speed*—about 650 mph. *Ceiling*—more than 40,000 ft.

DEPLOYMENT: *Location*—U.S. troops in West Germany, Far East. Also in hands of NATO allies. *Initially operational*—October, 1951. *Total divisions*—three. *Divisional strength*—about 50.

FRAME: *System contractor*—Martin. *Length*—39.6 ft. *Diameter*—54 in. *Wingspan*—28.7 ft. *Launch weight*—12,500 lbs. *Material (major)*—aluminum and magnesium.

GUIDANCE: *System contractor*—Air Force. *Type*—radar control.

BOOSTER: *System contractor*—Thiokol. *Propellant*—solid (JATO). *Thrust*—57,000 lbs.

SUSTAINER: *System contractor*—Allisan. *Engine*—J-33-37 turbo jet. *Thrust*—4200 lbs.

PAYLOAD: *Warhead type*—nuclear or HE.

G.S.E.: *Launcher*—Martin. *Fueling*—Martin. *Handling and service*—Martin. *Transport vehicles*—Martin.

REMARKS: Relatively mobile Matadors are being replaced by more advanced Maces. Matadors in West Germany are being turned over to German troops.

LACROSSE (Army)

MILITARY DESIGNATION: M4E2
TYPE: Surface-to-surface
STATUS: Operational
PRIME CONTRACTOR: The Martin Co.
PERFORMANCE: Range—20 miles. Speed—transonic.
DEPLOYMENT: *Location*—Two U.S. battalions in West Germany; five more in training in the United States. *Initially operational*—1959. *Total battalions*—seven. *Battalion strength*—four mobile launchers.
FRAME: *System contractor*—Martin. *Length*—19 ft. *Diameter*—20.5 in. *Launch weight*—2300 lbs.
GUIDANCE: *System contractor*—Martin. *Type*—command.
BOOSTER: *System contractor*—Thiokol. *Propellant*—solid.
PAYLOAD: *Warhead type*—nuclear or HE.
G.S.E.: *Launcher*—Martin. *Handling and service*—Martin.



LACROSSE

SHILLELAGH (Army)

TYPE: Surface-to-surface
STATUS: R&D
PRIME CONTRACTOR: Aeronutronic Division, Ford Motor Co.
PERFORMANCE: Designed to provide heavy firepower for close-in support of troops.
DEPLOYMENT: *Location*—to be deployed with U.S. combat troops. *Initially operational*—mid-1960's.
FIRE CONTROL: *System contractor*—Raytheon
PAYLOAD: *Warhead type*—nuclear.
REMARKS: There will be hand-carried and vehicle-mounted versions.

M-55 (Army)

TYPE: Surface-to-surface
STATUS: Operational
PRIME CONTRACTOR: Norris Thermador Co.
PERFORMANCE: Range—relatively short. Launched from 45-tube T45 launcher.
DEPLOYMENT: *Location*—U.S. combat troops in the United States and overseas. *Initially operational*—1960.
FRAME: *Diameter*—115 mm.
GUIDANCE: *Type*—free-flight.
BOOSTER: *Propellant*—solid.
PAYLOAD: *Warhead type*—chemical agents.

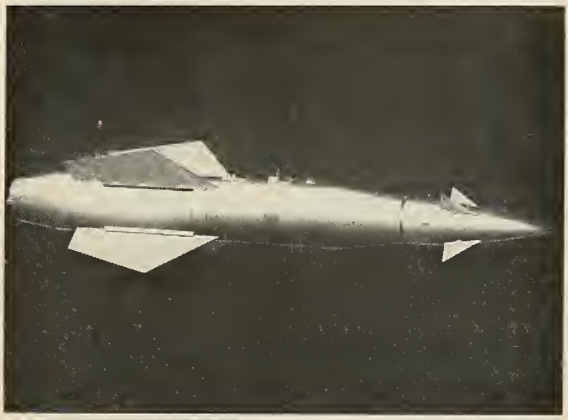
ADVANCED TACTICAL MISSILES

Project	Contractors	Description	Status
ARM (Navy)	No contracts announced	Air-to-surface anti-radar missile	R&D
COBRA (Navy)	No contracts announced	Anti-ship, anti-radar missile	R&D
GIMLET (Navy)	No contracts announced	Air-to-surface unguided, considered highly accurate	R&D
GPSSM (Army)	No contracts announced	General-purpose surface-to-surface missile	Study
LOBBER (Army)	No contracts announced	Surface-to-surface cargo carrier; 10-15 m. range; also can drop napalm	Study
RAVEN (Navy)	No contracts announced	Air-to-surface; about 500 m. range	Study
WAGTAIL (Air Force)	Minneapolis-Honeywell-prime	Family of RLM (Rearward Launched Missiles) launched from aircraft for various applications such as air-to-surface and air-to-air; inertial; finless.	Late R&D
WILLOW (Army)	Chrysler, prime	No details available	

AIR-TO-SURFACE

BULLPUP (Navy and Air Force)

MILITARY DESIGNATION: ASM-N-7A and B and GAM-83A and B
TYPE: Air-to-surface
STATUS: A models operational, B in late R&D
PRIME CONTRACTOR: The Martin Co./Maxson Corp. (second source)
PERFORMANCE: Range—three to 10 n. miles. *Speed*—Mach 1.8
DEPLOYMENT: *Location*—U.S. carriers, Marine Corps units and the Tactical Air Command. *Initially operational*—April, 1959, aboard the Carrier Lexington.
FRAME: *System contractor*—Martin. *Length*—11 ft. (A). *Diameter*—about 1 ft. (A). *Launch weight*—571 lbs. (A). *Material (major)*—aluminum.
GUIDANCE: *System contractor*—Martin. *Type*—command (visual reference).
BOOSTER: *System contractor*—Allegany Ballistics Lab and Thiokol. *Type*—solid and packaged liquid (Guardian).
PAYLOAD: *Warhead type*—HE (250-1000 lb.) or nuclear.
REMARKS: Navy and Air Force A models identical; Navy B carries larger HE warhead, AF B has nuclear warhead.


ADVANCED BULLPUP

ANTITANK



COBRA

COBRA (Marines)

TYPE: Antitank

STATUS: Operational

PRIME CONTRACTOR: Boelkow Entwicklungen, Munich, Germany, and Doystrom, Inc.

PERFORMANCE: *Range*—5940 ft. (max.); 5280 ft. (effective). *Speed*—191 mph.

DEPLOYMENT: *Location* — Marine evaluation units. Also see Foreign Missiles Section.

FRAME: *System contractor*—Boelkow (Europe); not determined for U.S. *Length*—30.7 in. *Diameter*—3.9 in. *Height*—13.6 in. *Wingspan* — 19 in. *Launch weight* — 20.2 lbs. *Material (major)*—plastic

GUIDANCE: *System contractor*—Boelkow (Europe); Doystram (U.S.) *Type*—wire.

BOOSTER: *System contractor*—Oerlikan (Europe). Not determined for U.S. *Propellant*—solid.

PAYLOAD: *Warhead type*—armor-piercing HE (5.5 lbs.)

REMARKS: Missile can be launched and guided by one man.



SS-10

SS-10 (Army)

TYPE: Antitank

STATUS: Operational

PRIME CONTRACTOR: Nord Aviation, Paris, France; General Electric Co. (U.S. licensee)

PERFORMANCE: *Range*—5250 ft. (effective). *Speed*—180 mph.

DEPLOYMENT: *Location*—U.S. Army combat units (launched from jeeps, helicopters and other mobile vehicles). Also see Foreign Missiles section.

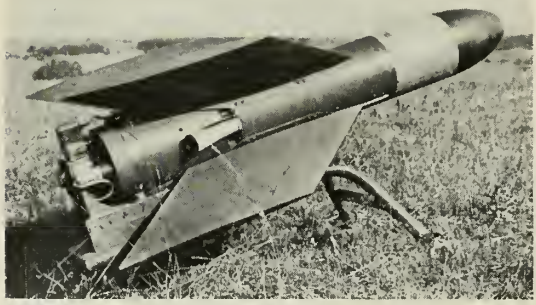
FRAME: *System contractor*—Nord (GE secondary source). *Length*—34 in. *Diameter*—6 in. *Wingspan*—30 in. *Launch weight*—33 lbs.

GUIDANCE: *System contractor*—Nord. *Type*—wire.

BOOSTER: *System contractor*—Nord. *Propellant*—solid.

PAYLOAD: *System contractor*—Strim. *Warhead type* — armor-piercing HE.

REMARKS: Initial U.S. Army procurement began in April, 1959. SS-10 can be carried and launched by one man. Army now phasing out stockpile and buying Entacs.



SS-11

SS-11 (Army)

TYPE: Antitank

STATUS: Operational

PRIME CONTRACTOR: Nord Aviation, Paris, France

PERFORMANCE: *Range* — 1650-11,500 ft. (effective). *Speed* — more than 400 mph.

DEPLOYMENT: *Location* — under evaluation by Army units. Also see Foreign Missiles section.

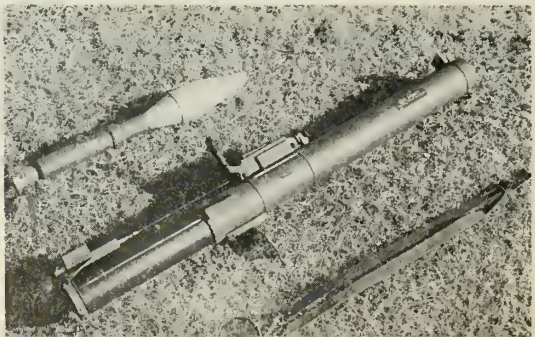
FRAME: *System contractor*—Nord. *Length*—46 in. *Diameter*—6 in. *Wingspan*—20 in. *Launch weight*—62 lbs.

GUIDANCE: *System contractor*—Nord. *Type*—wire.

BOOSTER: *System contractor*—Nord. *Propellant*—solid.

PAYLOAD: *System contractor* — *Strim. Warhead type* — armor-piercing HE.

LAW



LAW (Army)

TYPE: Antitank

STATUS: R&D

PRIME CONTRACTOR: Hesse-Eastern Division of Flightex Fabrics Inc.

PERFORMANCE: *Range* — 10-500 yds.

DEPLOYMENT: Intended for use by infantrymen.

FRAME: *Length*—20.8 in. *Diameter*—about 3.1 in.

GUIDANCE: Unguided

BOOSTER: *Type*—solid

PAYLOAD: *Warhead type*—armor-piercing HE

REMARKS: Missile is fired from shoulder-held tubular launcher similar to World War II Bazooka.



AIR/SPACE DEFENSE

The search goes on for a feasible defense against missiles and spacecraft.

A question mark still hovers over Nike-Zeus, the only fully R&D-funded U.S. anti-ICBM, which is awaiting tests against warheads in 1962 before a decision is made whether to commit it to production.

Deployment of Nike-Hercules and Bomarc antiaircraft missiles is expected to be completed in 1962.

ANTIAIRCRAFT

BOMARC A (Air Force)

MILITARY DESIGNATION: IM-99A

TYPE: Air-breathing surface-to-air

STATUS: Operotional

PRIME: Baeing Ca.

PERFORMANCE: *Range* — 250 n. miles. *Speed*—supersanic. *Ceiling* —more thon 68,000 ft.

DEPLOYMENT: *Locatian*—McGuire AFB, N.J.; Suffalk County AFB, N.Y.; Otis AFB, Mass.; Dow AFB, Maine; and Longley AFB, Va. *Initially aperotianal*—1959. *Tatal bases planned*—five. *Total squadrons planned* — five. *Squadran strength*—average about 40 missiles.

FRAME: *System cantractar*—Boeing. *Length*—47 ft. *Diameter*—35 in. *Wingspan*—18 ft. *Launch weight*—15,000 lbs. *Material (majar)*—stoinless steel.

GUIDANCE: *System* contractar—IBM and Westinghouse. *Type*—commond ond homing radar. (IBM SAGE guides missile to vicinity af torget when homing radar ossumes command.)

BOOSTER: *System cantractar*—Aerojet. *Propellant*—liquid.

SUSTAINER: *System cantractar*—Morquardt. *Engine* — (2) RJ-43 ramjets.

PAYLOAD: *Warhead type* — nucleor or HE.

G.S.E.: *Launcher-erectar* — Faad Mochinery.

BOMARC B (Air Force)

MILITARY DESIGNATION: IM-99B

TYPE: Air-breathing surface-ta-air

STATUS: Operationol

PRIME: Boeing Ca.

PERFORMANCE: *Range* — 400 n. miles. *Speed*—supersonic. *Ceiling* —mare than 70,000 ft.

DEPLOYMENT: *Locatian* — cantinentol United States (Duluth, Minn.; Niagara Falls, N.Y.; Kinchelae AFB, Mich.; Langley AFB, Va.; McGuire AFB, N.J.; Otis AFB, Mass.) and Canada. *Initially operatianal*—1961. *Tatal squadrans*—(U.S.) 6; (Canado) 2. *Tatal bases planned*—8. *Squadran strength*—28.

FRAME: *System contractar*—Baeing. *Length*—45 ft. *Diameter*—35 in. *Wingspan*—18 ft. *Launch weight*—16,000 lbs. *Material (majar)*—stoinless steel.

GUIDANCE: *System cantractar*—IBM and Westinghouse. *Type*—commond and rador haming. (IBM SAGE guides missile ta vicinity of target, when homing radar takes command.)

BOOSTER: *System cantractar*—Thiokal. *Propellant*—solid.

SUSTAINER: *System* contractar—Marquardt. *Engine*—(2) RJ-43 advonced ramjets.

PAYLOAD: *Warhead type* — nuclear ar HE.

G.S.E.: *Launcher-erectar* — Food Machinery.

REMARKS: Original number of squadrans planned was sharply cut. Bomarc B in March 1961 intercepted simulated supersonic target at 100,000 ft. and ronge af 446 s. miles.





NIKE-HERCULES *NIKE-AJAX*

NIKE-HERCULES (Army)

MILITARY DESIGNATION: SAM-A-25

TYPE: Surface-to-air (anti-missile copobility)

STATUS: Operotionol

PRIME CONTRACTOR: Western Electric Co.

PERFORMANCE: *Range* — more than 75 n. miles. *Speed*—Moch 3 plus. *Ceiling*—more thon 150,000 ft.

DEPLOYMENT: *Location*—United States, Western Europe, Far East. *Initially operational*—mid-1958. *Totol battolions*—about 20. *Battalion strength*—4 batteries. *Battery strength*—9 lounchers. *Totol launchers*—more than 700.

FRAME: *System contractor*—Douglas. *Length*—39 ft. *Diameter*—31.5 in. *Wingspan*—90 in. *Launch weight*—10,000 lbs. *Material (major)*—aluminum ond steel.

GUIDANCE: *System contractor*—Western Electric. *Type*—commond.

BOOSTER: *System contractor*—Hercules Powder. *Propellant*—solid.

SUSTAINER: *System contractor*—Thiokol. *Propellant*—solid.

PAYLOAD: *Warhead type*—nucleor or HE.

G.S.E.: *Launchers*—Consolidoted Western Steel. *Transport vehicles:* Fruehauf.

REMARKS: New General Electric rodars give Nike-Hercules the copobility of intercepting incoming tactical missiles. The Army plans to instoll improved system in Europe and other oppropriote areos. The Army also is expected to build mobile Nike-Hercules onti-missile botteries for deployment in the field.

NIKE-AJAX (Army)

MILITARY DESIGNATION: SAM-A-7

TYPE: Surfoce-to-oir

STATUS: Operationol

PRIME CONTRACTOR: Western Electric Co.

PERFORMANCE: *Range*—25 miles. *Speed*—Moch 2.5. *Ceiling*—60,000 ft.

DEPLOYMENT: *Location*—United States, Western Europe, For East. *Initially operational*—1953. *Total bottalions*—about 40. *Battalion strength*—4 batteries. *Bottery strength*—9 launchers. *Total lounchers*—neorly 1500.

FRAME: *System contractor*—Douglas. *Length*—31 ft. *Diameter*—12 in. *Wingspan*—52 in. *Lounch weight*—2300 lbs. *Materiol (major)*—aluminum and steel.

GUIDANCE: *System contractor*—Western Electric. *Type*—commond.

BOOSTER: *System contractor*—Thiokol. *Propellant*—solid.

SUSTAINER: *System contractor*—Thiokol. *Propellant*—liquid.

PAYLOAD: *Warhead type*—HE.

G.S.E.: *Lounchers*—Consolidoted Western Steel. *Transport vehicles*—Fruehouf.

REMARKS: Nike-Ajox is being reploced by the for more advonced Nike-Hercules.



HAWK (Army)

MILITARY DESIGNATION: XM3EI

TYPE: Surfoce-to-oir

STATUS: Operotionol

PRIME CONTRACTOR: Roytheon Co.

PERFORMANCE: *Range*—about 22 n. miles. *Speed* — Moch 2 plus. *Ceiling*—tree-top level to obout 40,000 ft. (Howk is specificolly designed for use againsf low-flying oircraft.)

DEPLOYMENT: *Location*—U.S. troops training with Howks in the United Stotes. *Initiolly operationol*—1959. *Battalions*—2. *Battalion strength*—3 to 5 batteries. *Battery strength*—6 to 12 launchers (3 missiles per louncher). Also to be used by Morine Corps and NATO allies. To be deployed in Europe, For East and Panama.

FRAME: *System contractor*—Raytheon/Northrop. *Length* — 17 ft. *Diameter*—14 in. *Wingspan*—48 in. *Launch weight*—1275 lbs. *Material (major)*—aluminum ond steel.

GUIDANCE: *System contractor*—Raytheon. *Type*—semi-octive rador homing.

BOOSTER: *System contractor*—Aerojet. *Propellant*—solid.

SUSTAINER: *System contractor*—Aerojet. *Propellont*—solid.

PAYLOAD: *Worhead type*—HE.

G.S.E.: *Louncher*—Northrop. *Handling and service* — Raytheon/Northrop / Food Mochinery / and RCA. *Transport vehicles* — Food Mochinery.

REMARKS: Although Howk is not on anti-missile missile, it hos successfully intercepted on Honest John, Little John ond Corporal in tests. Howk is highly mobile.

TALOS (Navy)

MILITARY DESIGNATION: SAM-N-6

TYPE: Surface-to-air and surface-to-surface (seagoing)

STATUS: Operational

PRIME CONTRACTOR: The Bendix Corp. *System engineer* — Vitro Corp.

PERFORMANCE: *Range* — more than 65 n. miles. *Speed*—about Mach 2.5. *Ceiling*—extremely high altitude.

DEPLOYMENT: *Location*—aboard the missile cruiser Galveston. To be deployed aboard at least six more cruisers including the nuclear-powered cruiser Long Beach. *Initially operational*—1959.

FRAME: *System contractor*—McDonnell. *Length*—about 30 ft. *Diameter*—about 30 in. *Launch weight*—7000 lbs. (booster alone weighs 4000 lbs.) *Material (major)*—steel.

GUIDANCE: *System contractor*—Bendix/Sperry. *Type*—beam riding.

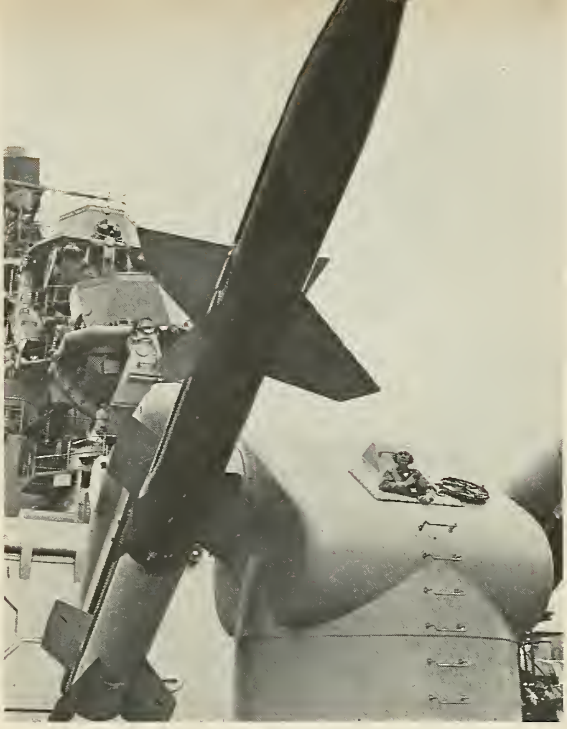
BOOSTER: *System contractor*—Allegany Ballistics Lab. *Type*—solid.

SUSTAINER: *System contractor*—Allegany. *Type*—ramjet.

PAYLOAD: *Warhead type*—nuclear or HE.

G.S.E.: *Launchers*—Naval Weapons Plant.

REMARKS: Improvements in the Talos system have led to work on the anti-missile system called Typhon.



TALOS

TERRIER (Navy)

MILITARY DESIGNATION: SAM-N-7.

TYPE: Surface-to-air and surface-to-surface (seagoing).

STATUS: Operational.

PRIME CONTRACTOR: Convair Division, General Dynamics Corp. *System engineer*—Vitro Corp.

PERFORMANCE: *Range*—about 10 n. miles. *Speed*—supersonic. *Ceiling*—more than 50,000 ft.

DEPLOYMENT: *Location*—aboard 20 ships including the Long Beach and the carrier Enterprise. Also used in a mobile version by Marines. *Initially operational*—1956.

FRAME: *System contractor*—Convair. *Length*—27 ft. (with 15 ft. booster). *Diameter*—12 in. *Launch weight*—about 3000 lbs.

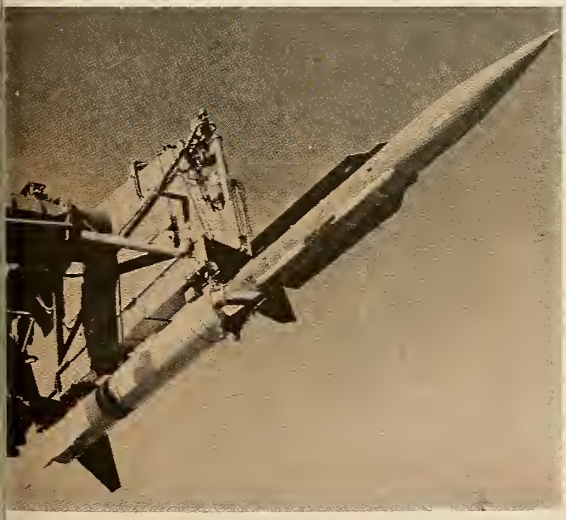
GUIDANCE: *System contractor*—Reeves/FTL/Sperry. *Type*—radar beam rider.

BOOSTER: *System contractor*—Allegany Ballistics Lab. *Propellant*—solid.

SUSTAINER: *System contractor*—Allegany Ballistics Lab. *Propellant*—solid.

PAYLOAD: *Warhead type*—HE.

REMARKS: Terrier is being replaced by the Convair Advanced Terrier. The Advanced Terrier's performance is about 100% greater than Terrier's. The Frigate Dewey is the first ship to be armed with Advanced Terrier.



TERRIER

TARTAR (Navy)

MILITARY DESIGNATION: Mark 15.

TYPE: Surface-to-air (seagoing)

STATUS: Operational.

PRIME CONTRACTOR: Convair Division, General Dynamics Corp. *System engineer*—Vitro Corp.

PERFORMANCE: *Range* — more 10 n. miles. *Speed*—supersonic. *Ceiling*—high-altitude.

DEPLOYMENT: *Location*—to be installed aboard 13 destroyers. *Initially operational*—1961.

FRAME: *System contractor*—Convair. *Length*—15 ft. *Diameter*—12 in. *Launch weight*—about 1500 lbs.

GUIDANCE: *System contractor*—Raytheon.

BOOSTER: *System contractor*—Aerojet. *Propellant*—solid.

PAYLOAD: *Warhead type*—HE.

G.S.E.: *Launcher*—Puget Sound Naval Shipyard. *Handling*—Washington Technological Associates/Naval Weapons Plant.



TARTAR



REDEYE

REDEYE (Army)

TYPE: Surface-to-air (shoulder-launched)

STATUS: Nearly operational

PRIME CONTRACTOR: Canvair Division, General Dynamics Corp.

PERFORMANCE: Designed to intercept low-flying jet aircraft. One man can operate and carry.

DEPLOYMENT: *Location*—to be deployed with Army and Marine combat troops. *Initially operational*—1962.

FRAME: *System contractor*—Canvair. *Length*—4 ft. *Diameter*—3 in. *Launch weight*—20 lbs.

GUIDANCE: *System contractor*—Philco/Canvair. *Type*—Infrared.

BOOSTER: *System contractor*—Atlantic Research. *Propellant*—solid.

PAYLOAD: *Warhead type*—HE.

REMARKS: Redeye is shipped, carried and launched from a disposable bazaako-shaped container. Program slipped.

ANTIMISSILE



NIKE-ZEUS

NIKE-ZEUS (Army)

TYPE: Surface-to-air anti-ICBM and IRBM.

STATUS: Late R&D

PRIME CONTRACTOR: Western Electric Co.

PERFORMANCE: *Range*—about 200 n. miles. *Speed*—est. Mach 4

DEPLOYMENT: *Location*—continental United States (particularly around soft SAC bases). *Initially operational*—about 1965. *Total batteries*—undetermined. *Battery strength*—to vary from about 30-50 launchers.

FRAME: *System contractor*—Douglas. *Length*—about 65 ft. *Diameter*—about 5 ft.

GUIDANCE: *System contractor*—Western Electric. *Type*—command.

BOOSTER: *System contractor*—Thiokol. *Propellant*—solid.

SUSTAINER: *System contractor*—Grand Central. *Propellant*—solid.

PAYLOAD: *Warhead type*—nuclear.

G.S.E.: *Launcher*—Douglas. *Handling and service*—Douglas.

REMARKS: The future of the Nike-Zeus system is in doubt. Both the Eisenhower and Kennedy Administrations have refused to permit the Army to begin production, thereby causing deployment to slip. However, plans for flight-testing the missile in the Pacific in late 1961 or early 1962 against Atlases have been approved.

MAULER (Army)

TYPE: Surface-to-air (anti-missile missile)

STATUS: R&D

PRIME CONTRACTOR: Convair Division, General Dynamics Corp.

PERFORMANCE: Designed to intercept incoming tactical missiles and jet aircraft.

DEPLOYMENT: *Location*—to be put in hands of Army combat units in near forward positions.

GUIDANCE: *Type*—radar.

BOOSTER: *Propellant*—solid.

REMARKS: Mauler will be launched from tracked vehicle manned by crew of only several men. System will be self-propelled and highly mobile and compact. Seagoing version has been proposed.

TYPHON (Navy)

TYPE: Surface-to-air (anti-missile missile)

STATUS: R&D

PRIME CONTRACTOR: Westinghouse Electric Corp./Applied Physics Lab.

PERFORMANCE: Designed to intercept both incoming tactical missiles and missiles launched from submerged submarines seconds after launching. *Range*—est. 100 n. miles. *Speed*—supersonic.

DEPLOYMENT: *Location*—aboard cruisers, destroyers and possibly hydrofoil destroyers.

BOOSTER: *Systems contractor*—Bendix.

PAYLOAD: *Warhead type*—nuclear or HE.

REMARKS: Two types are being developed—Long Range Typhon (formerly called Super Talos) and Medium Range Typhon (formerly called Super Tartar).



SIDEWINDERS on Northrop N156F

AIR-TO-AIR

SIDEWINDER (Navy-Air Force)

MILITARY DESIGNATION: AAM-N-7 (Navy) and GAR-8 (Air Force)

TYPE: Air-ta-air.

STATUS: Operatianal.

PRIME CONTRACTOR: Philco Carp./General Electric Co.

PERFORMANCE: *Range*—abaut 2 n. miles. *Speed*—supersanic. *Ceiling*—mare thon 50,000 ft.

DEPLOYMENT: *Location*—carried by carrier-based Naval aircraft and Air Defense Cammand aircroft. Alsa widely used by U.S. allies. *Initially operational*—mid-1956.

FRAME: *System contractor*—Norris Thermadar/Hunter-Douglas. *Length*—9 ft. *Diameter*—5 in. *Launch weight*—abaut 155 lbs. *Material (major)*—aluminum.

GUIDANCE: *System contractor*—Philca/GE. *Type*—Infrared.

BOOSTER: *System contractor*—Naval Propellant Plant. *Propellant*—solid.

PAYLOAD: *Warhead type*—HE.

REMARKS: Philca is prime cantractar far Sidewinder I-C, a second-generatian missile with greater speed and range. I-C will have switchable IR and radar haming warheads. The Naval Ordnance Test Station at China Lake, Calif., develaper af Sidewinder, alsa is develaping I-C.

ZUNI (Navy)

TYPE: Air-ta-surface.

STATUS: Operatianal.

PRIME CONTRACTOR: Naval Ordnonce Test Station, China Lake.

PERFORMANCE: *Range*—abaut 5 n. miles. *Speed*—about 3000 ft./sec.

DEPLOYMENT: *Location*—carrier-based aircraft. *Initially operatianal*—1957.

FRAME: *Length*—110 in. *Diameter*—5 in. *Launch weight*—107 lbs.

GUIDANCE: *Type*—free flight.

BOOSTER: *System contractor*—Hunter-Douglas. *Type* — solid. *Thrust*—7000 lbs.

PAYLOAD: *Warhead type*—HE (alsa variety af ather conventianal warheads including flares.)

REMARKS: The four-rocket launchers, which alsa are used for transparting and storing Zunis, can be jettisaned fram plane after rackets are launched. AD-type Naval aircraft can carry up ta 48 Zunis.



ZUNI



GENIE

GENIE (Air Force)

MILITARY DESIGNATION: MB-1

TYPE: Air-to-air.

STATUS: Operational.

PRIME CONTRACTOR: Douglas Aircraft Co.

PERFORMANCE: *Range*—about 6 n. miles. *Speed*—supersonic.

DEPLOYMENT: *Location*—aboard Air Defense Command aircraft (F-89's, F-101's, F-106's). *Initially operational*—about 1958.

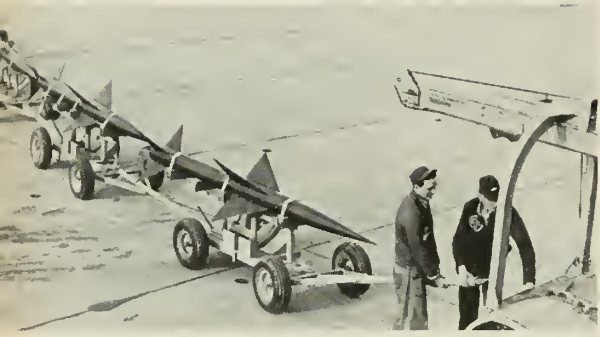
FRAME: *System contractor*—Douglas. *Length*—9.5 ft. *Launch weight*—about 800 lbs.

GUIDANCE: *Type*—free flight.

BOOSTER: *System contractor*—Aerojet. *Propellant*—solid.

PAYLOAD: *Warhead type*—nuclear.

G.S.E.: *Launcher*—Douglas. *Handling and service*—Douglas. *Transport vehicles*—Fruehauf.



SPARROW

SPARROW III (Navy)

MILITARY DESIGNATION: AAM-N-6A.

TYPE: Air-to-air.

STATUS: Operational.

PRIME CONTRACTOR: Raytheon Co.

PERFORMANCE: *Range* — more than 5 n. miles. *Speed*—more than Mach 2.

DEPLOYMENT: *Location*—carrier-based U.S. Navy aircraft. Also with Marine units. *Initially operational*—August, 1958, replacing Sparrow I.

FRAME: *System contractor*—Raytheon. *Length*—12 ft. *Diameter*—8 in. *Launch weight*—400 lbs. *Material (major)*—aluminum.

GUIDANCE: *System contractor*—Raytheon. *Type*—radar homing.

BOOSTER: *System contractor*—Aerojet. *Propellant*—solid (A new version of Sparrow with greater capability has Thiokal booster with packaged liquid propellant.) *Thrust (solid)*—7800 lbs.

PAYLOAD: *Warhead type*—HE.

G.S.E.: *Handling and service*—Raytheon.

REMARKS: Sparrow gave the Navy an all-weather missile when Sidewinder had only IR guidance.



FALCON GAR-11

FALCON (Air Force)

MILITARY DESIGNATION: GAR-1 through GAR-4 and GAR-11.

TYPE: Air-to-air.

STATUS: Operational (GAR-1 through GAR-4) and late R&D GAR-11).

PRIME CONTRACTOR: Hughes Aircraft Co.

PERFORMANCE: *Range*—about 5 n. miles. *Speed*—supersonic. (Greater ranges and speeds for GAR-3 and GAR-4, and GAR-11).

DEPLOYMENT: *Location*—Air Defense Command aircraft (F-89, F-101, F-102 and F-106). *Initially operational*—1957 (first versions). GAR-11 nearly operational.

FRAME: *System contractor*—Hughes. *Length*—about 6.5-7 ft. (GAR-11 is more than 7 ft.). *Diameter*—6.4 in. GAR-11 is 7 ft. 11 in.) *Wingspan*—20 in. *Launch weight*—more than 120 lbs. (GAR-11 is more thon 200 lbs.).

GUIDANCE: *System contractor*—Hughes. *Type*—(GAR-1D and GAR-3) radar homing; (GAR-2 and GAR-4) infrored.

BOOSTER: *System contractor*—Thiokol. *Propellant*—solid.

PAYLOAD: *Warhead type*—(GAR-1 through GAR-4) HE; GAR-11 nucleor.

REMARKS: GAR-3 and GAR-4 ore known as Super Falcons.

ANTI-SUBMARINE



WEAPON ALFA



SUBROC

ASROC



Missiles for attacking submarines have taken a great step forward. Asroc and Subroc—two of the most advanced ASW missiles—are now operational.

The stumbling block in ASW continues to be detection and identification. Any improvements in this area can be followed quickly by improved missiles.

WEAPON ALFA (Navy)

TYPE: ASW surface-ta-underwater

STATUS: Operatianal

PRIME CONTRACTOR: Navy

PERFORMANCE: *Range* — abaut 900 yards.

DEPLOYMENT: *Lacatian*—aboard U.S. destroyers and cruisers. *Initially aperatianal*—1952

FRAME: *System cantractar*—Avca. *Length*—8.5 ft. *Diameter*—12.75 in. *Launch weight*—500 lbs.

GUIDANCE: *Type*—free flight

BOOSTER: *Prapellant*—salid

PAYLOAD: *Warhead type* — HE depth charge

REMARKS: Alfa is launched fram guns maunted in turrets.

ASTOR (Navy)

TYPE: ASW racket torpedo

STATUS: R&D

PRIME CONTRACTOR: Westinghouse Electric Corp.

PERFORMANCE: *Range*—reported to be about 11 n. miles.

DEPLOYMENT: *Lacatian* — aboard U.S. fleet submarines.

FRAME: *System cantractar*—Westinghouse. *Length*—nearly 20 ft. *Launch weight*—mare than 2000 lbs.

GUIDANCE: *Type*—reported to be partly wire.

POWERPLANT: *Type*—reparted to be electric and racket-baosted. *Prapellant*—salid.

PAYLOAD: *Warhead type* — nuclear ar HE.

SUBROC (Navy)

TYPE: ASW underwater-to-underwoter

STATUS: R&D

PRIME CONTRACTOR: Gaadyear Aircraft Carp.

PERFORMANCE: *Range*—abaut 25 n. miles.

DEPLOYMENT: *Lacatian* — abaard nuclear-powered attack submarines. Scheduled ta be installed first abaard the Thresher. *Initially aperatianal*—1961 ar early 1962.

FRAME: *System cantractar*—Goadyear.

GUIDANCE: *System cantractar*—Kearfatt.

FIRE CONTROL: *System cantractar*—Librascope.

BOOSTER: *System cantractar* — Thiakal. *Type*—salid.

PAYLOAD: *Warhead type* — nuclear or HE.

REMARKS: Subroc will be launched underwater fram a conventianal submarine tube, leave the water, travel thraugh the air and re-enter the water to strike an enemy submarine.

ASROC (Navy)

TYPE: ASW surface-to-underwater

STATUS: Operational

PRIME CONTRACTOR: Minneapalis-Honeywell Regulator Co.

PERFORMANCE: *Range*—abaut 8 n. miles. *Speed*—nearly Mach 1.

DEPLOYMENT: *Lacatian*—Destrayer Leoder Narfalk and Destrayer Peary. The Navy plans to install ASROC aboard a tatal af 150 destrayers and cruisers within the next few years. *Initially aperatianal*—1960. *Launcher capacity*—eight. (Some ships will carry relaads).

FRAME: *System cantractar*—Minneapolis-Haneywell. *Length* — 15 ft. *Tarpeda-warhead length*—100 in. *Missile diameter*—1 ft. *Overall diameter*—2.5 ft. *Launch weight*—abaut 1000 lbs.

FIRE CONTROL: *System cantractar*—Librascope. *Type*—digital computer operated.

SONAR DETECTION: *System cantractar*—Sangamo Electric. *Type*—SQS-23.

BOOSTER: *Prapellant*—salid.

PAYLOAD: *Warhead* — General Electric Mark 44 acaustic haming torpedo or depth charge. *Type*—HE (depth charge can be nuclear).

G.S.E.: *Launcher*—Universal Match.



FOREIGN MISSILES

BLUE STEEL

Russia is believed to be improving and strengthening its ICBM and tactical missile forces. They also are reported working hard on an anti-ICBM.

NATO countries, meantime, are bringing out a number of improved tactical missiles. France is in the forefront with antitank and ASW missiles and the new air-to-surface AS-30. Britain is pushing its new tactical Blue Water—expected to be operational in 1963.

West Germany is a growing customer for tactical missiles, while France is making its own nuclear weapons in the buildup against Soviet might. The U.S. is buying some foreign missiles.

GREAT BRITAIN

BLUE STEEL (RAF)

TYPE: Air-to-surface (tactical)

STATUS: Productian

PRIME CONTRACTOR: A. V. Roe & Co., Ltd. (Hawker Siddeley Graup).

PERFORMANCE: *Range* — abaut 500 miles. *Speed*—Mach 12. *Ceiling*—abaut 60,000 ft.

DEPLOYMENT: *Locatian*—ta be air-launched fram British Vulcan bombers.

FRAME: *Length*—36 ft. *Wingspan*—abaut 13 ft. *Launch weight*—abaut 15,000 lbs.

GUIDANCE: *System cantractar*—Elliatt Bras. Ltd. *Type*-inertial.

POWERPLANT: *Prapellant*—liquid

BOOSTER: *System cantractar*—Bristal Siddeley Engines Ltd. *Prapellant* — liquid. *Thrust* — 16,000 lbs.

PAYLOAD: *Warhead type*—nuclear ar HE.



FIRESTREAK

FIRESTREAK (RAF)

TYPE: Air-to-air

STATUS: Operatianal

PRIME CONTRACTOR: de Havilland Aircraft Co. Ltd. (HSG)

PERFORMANCE: *Range*—about 5 miles. *Speed*—Mach 2.3.

DEPLOYMENT: *Locatian* — with RAF squadrans and air units of the Royal Navy.

FRAME: *Length*—10.5 ft. *Diameter*—8.5 in. *Launch weight*—300 lbs.

GUIDANCE: *Type*—infrared.

BOOSTER: *Type*—solid.

PAYLOAD: *Type*—HE.

BLUE STREAK (RAF)

TYPE: IRBM surface-ta-surface.

REMARKS: Pragram cancelled 1960; baaster development cantinued far passible space wark.

BLOODHOUND I (RAF)

TYPE: Air-breathing surface-to-air.

STATUS: Operationol.

PRIME CONTRACTOR: Bristol Aircraft Ltd. (British Aircraft Corp.).

PERFORMANCE: *Range*—about 35 miles. *Speed*—Mach 2.3.

DEPLOYMENT: *Location*—combat units in Britain and Australia. Also has been sold to Sweden.

FRAME: *Length*—25.3 ft. *Launch weight*—4500 lbs.

GUIDANCE: *System contractor*—Ferranti, Ltd. *Type*—radar homing.

BOOSTERS: *Type*—solid (4).

SUSTAINERS: *System cantractar*—Bristol-Siddeley. *Engine* — Thor ramjets. *Thrust*—total 15,000 lbs.

REMARKS: Bristol Aircraft is developing an odvanced version called Bloodhound II. It may have anti-missile capability.

BLUE WATER (Army)

TYPE: Surface-to-surface (tactical).

STATUS: Pre-production evaluation.

PRIME CONTRACTOR: English Electric Aviation Co., Ltd. (BAC).

PERFORMANCE: Range — about 80-100 miles.

DEPLOYMENT: None.

FRAME: *Length*—25 ft. *Diameter*—2 ft. *Wingspan*—6.9 ft. *Finspan*—6.5 ft.

GUIDANCE: Inertial.

BOOSTER: *Type*—solid.

PAYLOAD: *Warhead type*—nuclear or HE.

REMARKS: Highly mobile. Response time of 10 min. Expected to be operationol in 1963. Being eyed for purchose by NATO; West Germany and Sweden.

SEACAT (Navy)

TYPE: Ship-to-air

STATUS: Operational.

PRIME CONTRACTOR: Short Bros. and Harland Ltd.

PERFORMANCE: *Range*—about 4 m. *Speed*—Mach 1.

DEPLOYMENT: *Location*—aboard Royal Naval destroyers and cruisers. Also ordered by West German, Swedish, Australian and New Zealand navies. *Initially operational*—1960.

GUIDANCE: *Type*—radio command.

FRAME: *Length*—4 ft. 10 in. *Wingspan*—2 ft.

BOOSTER: *Type*—solid.

SUSTAINER: *Type*—solid.

PAYLOAD: *Warhead type*—HE.

REMARKS: Four missiles on one battery.



THUNDERBIRD



BLUE WATER

THUNDERBIRD (Army)

TYPE: Surface-to-air

STATUS: Operationol

PRIME CONTRACTOR: English Electric Aviation. Ltd. (BAC).

PERFORMANCE: *Range*—25 n. miles. *Speed*—about Mach 2.

DEPLOYMENT: *Location* — with British Army combat troops. *Initially operational*—1959.

GUIDANCE: *System contractar*—Marconi Instruments. *Type*—radar homing.

BOOSTER: *System cantractar:* Bristol. *Type*—solid (4).

SUSTAINER: *System contractar:* I.C.I. *Type*—solid.

PAYLOAD: *Warhead type*—HE.

REMARKS: Launched from mobile carriers. Advanced Thunderbird with low-level capability and increased range entering production.

FAIREY A-T (Army)

TYPE: Surface-to-surface (anti-tank).

STATUS: Believed to be under development.

PRIME CONTRACTOR: Fairey Engineering, Ltd.

PERFORMANCE: Not available.

GUIDANCE: *Type*—reported to be radar.

PYTHON

TYPE: Surface-to-surface (anti-tank)

STATUS: RDT&E

PRIME CONTRACTOR: Pye, Ltd.

PERFORMANCE: Not available.

FRAME: *Length*—5 ft. *Fin span*—2 ft. *Launch weight*—80 lbs.

BOOSTER: *Propellant*—solid

GUIDANCE: *Type*—wire.

POWERPLANT: *Type*—2 stage solid.

REMARKS: Proposals submitted.

RED TOP (RAF)

TYPE: Air-to-air

STATUS: R&D

PRIME CONTRACTOR: de Havilland Aircraft Co. Ltd. (HSG)

PERFORMANCE: *Range*—about 9.5 miles. *Speed*—about Mach 3

DEPLOYMENT: *Location*—to replace Firestreak on various aircraft.

FRAME: *Length*—10.6 ft. *Wingspan*—3 ft. *Diameter*—8¾ in.

GUIDANCE: *Type*—infrared.

BOOSTER: *Type*—solid.

PAYLOAD: *Warhead type*—HE (68 lbs.).

REMARKS: Apparently designed within the same concept as the U.S. Navy's Eagle.

FIREFLASH (RAF)

TYPE: Air-to-oir

STATUS: Operatianal (troining)

PRIME CONTRACTOR: Fairey Aviatian Ltd.

PERFORMANCE: *Range*—several miles. *Speed*—mare than Mach 2.

DEPLOYMENT: *Lacatian* — RAF squadrans use far training.

FRAME: *Length*—7 ft. 5 in. *Wingspan*—28.1 in. *Diameter*—5.5 in. *Launch weight*—300 lbs.

GUIDANCE: *Type*—beam riding.

BOOSTER: *Type*—salid. *Number*—twa.

PAYLOAD: *Type*—HE.

REMARKS: Fireflash has been replaced as an operatianal missile by the Firestreak.

SEASLUG (Navy)

TYPE: Surface-to-oir

STATUS: Operational

PRIME CONTRACTOR: W. G. Armstrong Whitworth Aircroft, Ltd. (HSG).

PERFORMANCE: Range—long.

DEPLOYMENT: *Lacatian*—ta be deployed aboord Navy guided missile destroyers. *Initially aperatianal*—1961.

FRAME: *Length*—19.5 ft. *Diameter*—1.5 ft. *Wingspan*—4.5 ft.

GUIDANCE: *System cantractar*—General Electric. *Type*—beam riding.

BOOSTER: *Type*—salid (4).

SUSTAINER: *Type*—solid.

PAYLOAD: *Warhead type*—HE (nuclear later).

TIGERCAT

TYPE: Surface-ta-oir

STATUS: R&D

PRIME CONTRACTOR: Short Brothers ond Harland Co., Ltd.

PERFORMANCE: Designed os mobile anti-aircraft to be launched fram armored carriers. Evalved fram Seacat.

REMARKS: Under consideration by British Army.

VIGILANT

TYPE: Surface-ta-surface (anti-tank)

STATUS: Under Army evaluotion.

PRIME CONTRACTOR: Vickers-Armstrangs, Ltd. (BAC).

PERFORMANCE: Range—200 to 1700 yards. *Speed*—350 mph.

DEPLOYMENT: None. NATO countries considering.

FRAME: *Length*—3 ft. *Diameter*—4.5 in. *Launch weight*—abaut 26 lbs.

GUIDANCE: *Type*—wire, with gyro auta-pilat.

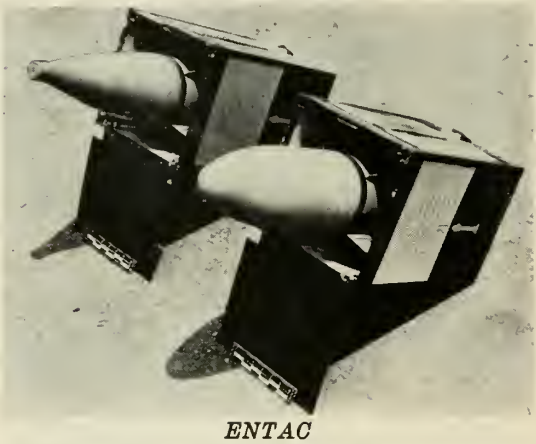
BOOSTER: *Propellant*—solid.

PAYLOAD: Two types of HE warheod.

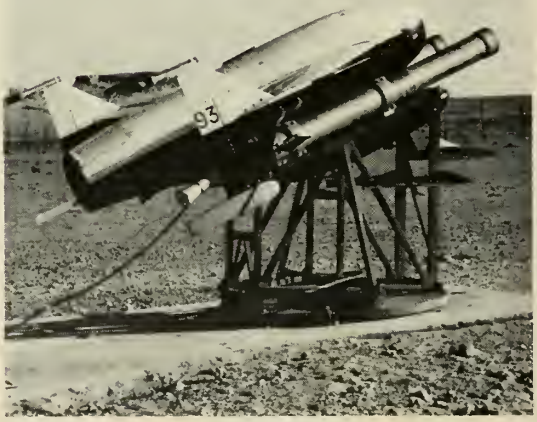
REMARKS: Designed far use by infantrymen.



BLOODHOUND



ENTAC



CAISSEUR

FRANCE

R530 (Air Force and Navy)

TYPE: Air-to-oir

STATUS: Advonced develapment

PRIME CONTRACTOR: MATRA

PERFORMANCE: Range—10 mi. *Speed*—Mach 1.1

DEPLOYMENT: Intended far the Mirage III and Sud Vautour aircraft

FRAME: *Length*—about 6.5 ft. Has delta cruciform wings with aerodynamic cantrols like U.S. Falcon

GUIDANCE: Twa versions—electramagnetic and IR

BOOSTER: *Type*—Hotchkiss-Brandt salid

SUSTAINER: *Type* — Hotchkiss-Brandt solid

PAYLOAD: *Warhead type*—HE.

AS 30 (Air Force and Navy)

TYPE: Air-to-surface

STATUS: Evaluation triols by NATO

PRIME CONTRACTOR: Nord Aviation

PERFORMANCE: Range—almost 9 mi. *Speed*—supersonic

FRAME: *Length*—12.42 ft. *Diameter*—13.8 in. *Span*—3.28 ft. *Tatal weight*—1100 lbs.

GUIDANCE: Praportional contral

BOOSTER: *Type*—salid

SUSTAINER: *Type*—salid

PAYLOAD: *Warheod type*—HE or nuclear

REMARKS: Competitor to the U.S. Bullpup.

AA-20 (Air Force)

TYPE: Air-to-air and air-to-surface

STATUS: Operational

PRIME CONTRACTOR: Nord Aviation

PERFORMANCE: Range — 2.5 miles. *Speed*—supersonic.

DEPLOYMENT: *Lacatian*—in hands af Air Farce and Navy units.

FRAME: *Length*—8.5 ft. *Launch weight*—(a/a version) 295 lbs. (a/s version) between 295 and 375 lbs.

GUIDANCE: *Type*—radio cammand.

BOOSTER: *Type*—salid.

SUSTAINER: *Type*—solid.

PAYLOAD: *Warhead type*—HE.

REMARKS: Industrial designatian AA 5103 has been adopted far NATO use.

VEGA

TYPE: Surface-to-air

STATUS: R&D

PRIME CONTRACTOR: Nard Aviatian.

PERFORMANCE: *Range*—115,000 ft. *Speed*—about Mach 5.

FRAME: *Length*—32.5 ft. *Wingspan* 11.8 ft.

BOOSTER: *Type*—salid.

SUSTAINER: *Type*—ramjet.

ACAM 5301 (Army)

TYPE: Surface-to-air

STATUS: R&D

PRIME CONTRACTOR: Nard Aviation.

PERFORMANCE: *Range*—neorly 10 n. miles. *Speed*—abaut Mach 2.

DEPLOYMENT: *Locatian*—ta be deployed with Army combat troaps, particularly for use against law-flying aircraft.

FRAME: *Length*—14.5 ft. *Wingspan*—about 5 ft. *Launch weight*—1600 lbs.

GUIDANCE: *Type*—radio.

BOOSTER: *Type*—solid.

SUSTAINER: *Type*—salid.

PAYLOAD: *Warhead type*—HE (nearly 90 lbs.)

CAISSEUR (Army)

MILITARY DESIGNATION: SE4200

TYPE: Air-breathing surface-ta-surface (tactical)

STATUS: Operatianal

PRIME CONTRACTOR: Sud-Aviatian

PERFORMANCE: *Range*—60 n. miles. *Speed*—Mach .8

DEPLOYMENT: *Locatian* — French Army combat troaps.

FRAME: *Length*—11.5 ft. *Wingspan*—9 ft. 9 in. *Launch weight*—2075 lbs.

GUIDANCE: *Type*—radar cammand.

BOOSTER: *Type*—solid (2).

SUSTAINER: *Engine*—ramjet.

PAYLOAD: *Warhead type*—HE.

REMARKS: Launched fram mobile carrier.

ENTAC (Army)

TYPE: Surface-ta-surface (anti-tank)

STATUS: Productian

PRIME CONTRACTOR: Nard Aviatian

PERFORMANCE: *Range*—abaut 1 mile. *Speed*—abaut 180 mph.

DEPLOYMENT: Being purchased by U.S. and Belgian armies.

GUIDANCE: Type—wire.

BOOSTER: *Type*—salid.

PAYLOAD: *Warhead type*—HE.

REMARKS: Jaint Nard and DEFA development.



MALAFON

MALAFON (Navy)

TYPE: Surface-ta-underwater (ASW)

STATUS: Ta be aperatianal 1962; in service 1963.

PRIME CONTRACTOR: Societe Industrielle d'Aviatian Latecaere

PERFORMANCE: *Range* — mare than 10 *n.* miles.

DEPLOYMENT: *Locatian*—first deplayed aboard the 3750-tan ASW Command Ship La Galissaniere.

FRAME: *Type* — racket-baasted homing torpedo similar ta U.S. Navy's Asrac.

GUIDANCE: *Type*—sanar and radia cammand.

BOOSTER: *Type*—salid.

PAYLOAD: *Warhead type*—HE.

MASALCA (Navy)

TYPE: Air-breathing surface-to-air

STATUS: Nearly aperational

PRIME CONTRACTOR: Saciete industrielle d'Aviatian Latecaere

PERFORMANCE: *Range*—about 65 *n.* miles.

DEPLOYMENT: *Locatian*—abaard French cruisers. *Initially* aperatianal—1960.

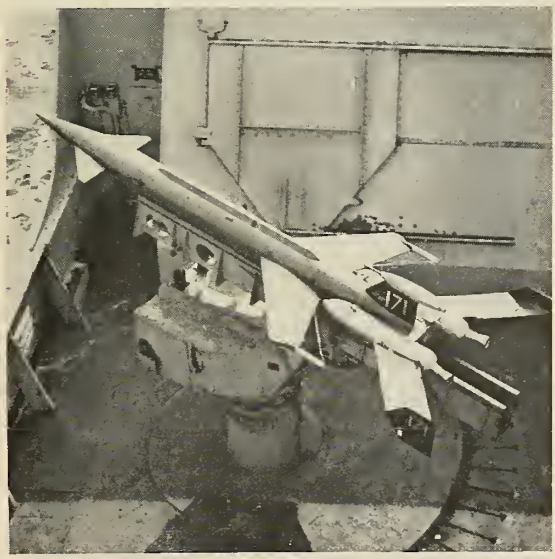
FRAME: *Launch weight* — 6000 lbs.

GUIDANCE: *Type*—beam rider.

BOOSTER: *Type*—salid.

SUSTAINER: *Type*—ramjet.

PAYLOAD: *Warhead type*—HE.



MARUCA

MALAFAC (Navy)

TYPE: Surface-to-surface

STATUS: R&D

PRIME CONTRACTOR: Societe Industrielle D'Aviation Latecoere

PERFORMANCE: *Range*—abaut 25 n. miles.

DEPLOYMENT: *Locatian*—ta be installed abaard French surface warships.

FRAME: *Length*—20.5 ft.

GUIDANCE: Radia cammand.

BOOSTER: *Type*—solid.

SUSTAINER: *Type*—liquid (acid/furaline).

PAYLOAD: *Warhead type*—HE.

REMARKS: Malafac test missiles have been launched many times at sea.

MARUCA (Navy)

TYPE: Surface-to-air

STATUS: Operational (training)

PRIME CONTRACTOR: Ruelle Naval Arsenal

PERFORMANCE: *Range*—abaut 10 n. miles.

DEPLOYMENT: *Locatian* — used abaard French Experimental Missile Ship Ile-D'Oléran (converted transpart) far training.

FRAME: *Length*—15 ft. *Wingspan*—5 ft.

GUIDANCE: *Type*—radar command.

BOOSTER: *Type*—solid (4).

SUSTAINER: *Type*—liquid (nitric acid/aniline).

PAYLOAD: *Warhead type*—HE.

REMARKS: Develapment vehicle far Masurca.

MASURCA (Navy)

TYPE: Surface-to-air

STATUS: Operational

PRIME CONTRACTOR: Ruelle Naval Arsenal

PERFORMANCE: *Range* — 25 n. mi. *Speed*—Moch 1.9

DEPLOYMENT: *Locatian* — to be installed abaard helicopter carrier Jeanne d'Arc, new packet cruisers and Surcouf-class squadron escarts over 3000 tans as the French Navy's tap oir defense weapon. *Initially* aperatianal—1960.

FRAME: *Length*—18.5 ft. *Wingspan*—3 ft. *Launch weight*—3200 lbs.

GUIDANCE: *Type*—radar beam rider.

BOOSTER: *Type*—solid.

SUSTAINER: *Type*—salid.

PAYLOAD: *Warhead type* — HE (220 lbs.)

REMARKS: Masurca I & II advanced madels under development.

R-422B3 (Army)

TYPE: Surface-ta-air

STATUS: Operatianal

PRIME CONTRACTOR: MATRA

PERFORMANCE: *Range*—abaut 60 n. miles. *Speed*—Mach 2.6

DEPLOYMENT: *Locatian*—metrapalitan France. *Initiolly* aperotional—1960.

FRAME: *Length*—30.5 ft. *Launch weight*—3500 lbs.

GUIDANCE: *Type* — radar cammond and haming.

BOOSTER: *Type*—SEPR 732 salid.

SUSTAINER: *Type* — SEPR 706 salid.

PAYLOAD: *Warhead type*—HE (110 lbs.).

REMARKS: R-422B2 is mabile. MATRA R-431, designed ta intercept high-altitude supersanic bambers, is under develapment. R-431 will be pawered by a salid baaster and a Nard ramjet.

PARCA (Army)

TYPE: Surface-ta-air

STATUS: Operatianal

PRIME CONTRACTOR: DEFA

PERFORMANCE: *Range*—15 miles. *Speed* — supersanic. *Ceiling* — 80,000 ft.

DEPLOYMENT: Used mainly far training.

FRAME: *Length*—18 ft. *Launch weight*—2200 lbs.

GUIDANCE: *System cantractar*—C. F. Thamsan-Haustan. *Type*—radar cammand.

BOOSTER: *Type*—salid (4).

SUSTAINER: *Type*—salid.

PAYLOAD: *Warheod type*—HE.

REMARKS: Advanced versian far use against Mach 3 aircraft under develapment.

SS-12 (Army)

TYPE: Surface-ta-surface and air-ta-surface (antitank)

STATUS: R&D

PRIME CONTRACTOR: Nard Aviatian

PERFORMANCE: Range — mare than 4 miles. *Speed*—Mach 1.

DEPLOYMENT: *Lacatian* — ta be deplayed with French Army cambat traaps. Alsa, can be launched fram light aircraft and helicapters.

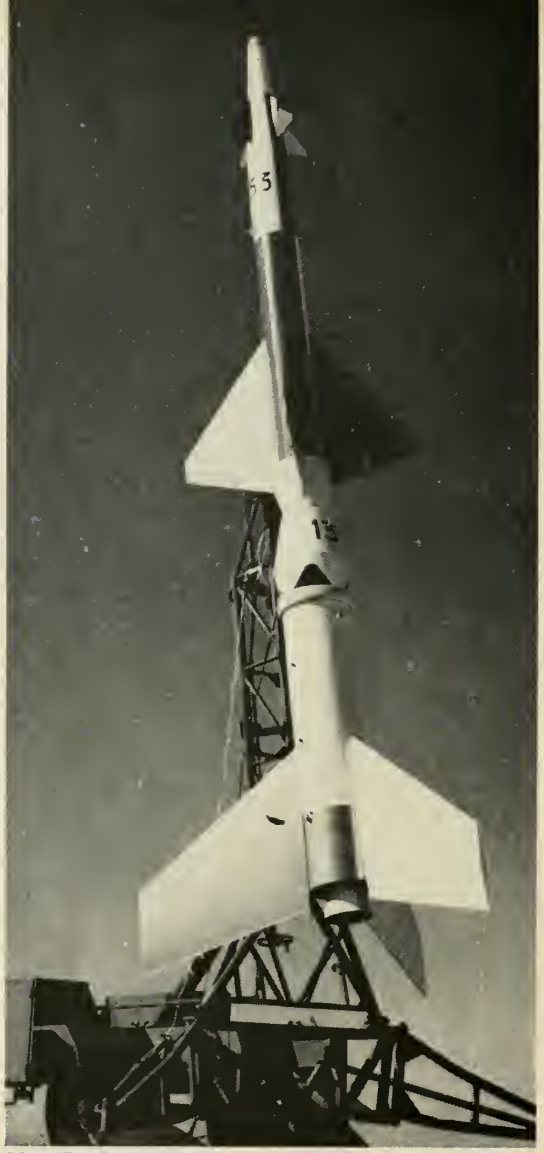
FRAME: *Length* — abaut 6 ft. *Wingspan*—about 32 in. *Launch weight*—150 lbs.

GUIDANCE: *Type* — wire. Alsa radar versian.

BOOSTER: *Type*—salid.

PAYLOAD: *Warhead type*—nuclear and HE.

REMARKS: SS-12 scheduled ta be in praductian by May, 1961. SS-12 is an advanced versian af the Nard SS-10 and SS-11 (See U.S. missiles) which are in the hands af a large number af NATO armies.



MATRA R422B3

PARCA



R-511 (Air Force)

TYPE: Air-ta-air

STATUS: Operatianal

PRIME CONTRACTOR: MATRA

PERFORMANCE: Range—abaut 5 miles. *Speed*—supersanic.

DEPLOYMENT: *Lacatian*—carried abaard French interceptars.

FRAME: *Length*—10 ft. *Diameter*—10 in. *Launch weight*—abaut 400 lbs.

GUIDANCE: *Type* — electramagnetic semi-passive.

BOOSTER: *System cantractor*—Hatchkiss-Brandt. *Type* — salid. *Thrust*—3500 lbs.

SUSTAINER: *System contractor*—Hatchkiss-Brandt. *Type* — salid. *Thrust*—440 lbs.

PAYLOAD: *Warhead type*—HE.

REMARKS: Ta be replaced by advanced MATRA R-530 abaut 1962.

SE 4400 (Air Force)

TYPE: Air-breathing surface-ta-air.

STATUS: Operatianal

PRIME CONTRACTOR: Sud-Aviatian

PERFORMANCE: Range—24.8 n. miles. *Speed*—Mach 3.3. *Ceiling*—130,000 ft.

DEPLOYMENT: *Lacation*—ta be used far French high altitude experiments.

FRAME: *Length*—26.5 ft. *Launch weight*—2640 lbs.

GUIDANCE: *Type*—radar haming.

BOOSTER: *Type*—salid.

SUSTAINER: *Type*—ramjet.

SSBS-1

TYPE: IRBM surface-ta-surface

STATUS: R&D

PRIME CONTRACTOR: Saciete d'Etude et de Realisatian d'Engins Balistiques

PERFORMANCE: *Range*—2300 n. miles.

PAYLOAD: *Warhead type*—nuclear.

JAPAN

TAAM-1D (Air Force)

TYPE: Air-ta-air

STATUS: R&D

PRIME CONTRACTOR: Fuji Precisian Machinery Ca., Ltd.

PERFORMANCE: Range — abaut 1.5 miles. *Speed*—Mach 1.5.

FRAME: *Length*—8 ft. *Launch weight*—335 lbs.

GUIDANCE: *Type*—infrared.

PAYLOAD: *Warhead type*—HE.

TATM-1 (Army)

TYPE: Surface-ta-surface (anti-tank)

STATUS: R&D

PRIME CONTRACTOR: Kawasaki Kakuki Kagyu Kabushi-iki Kaisha

FRAME: *Length*—4.5 ft. *Launch weight*—300 lbs.

REMARKS: TATM-2 madel alsa under develapment. It is 3.2 ft lang.

TLRM-1 (Army)

TYPE: Surface-ta air

STATUS: R&D

PRIME CONTRACTOR: Shin Mitshubishi, Mitshubishi Shipbuilding and Engineering Co.

PERFORMANCE: Range — lang. Speed—abaut 255 mph.

FRAME: *Length*—10.5 ft. *Launch weight*—abaut 560 lbs.

GUIDANCE: Type—passibly radar.

TMA-1 (Air Force)

TYPE: Air-ta-air

STATUS: R&D

PRIME CONTRACTOR: Shin Mitsubishi and Mitsubishi Electrical.

PERFORMANCE: Speed — supersanic.

FRAME: *Length* — abaut 10 ft. *Launch weight*—mare than 200 lbs.

BOOSTER: *System contractor*—Fuji Precisian. *Type*—salid.

PAYLOAD: *Warhead type*—HE.

REMARKS: MM-1 is a test vehicle far the TMA-1.

NORWAY

TERNE III (Navy)

TYPE: Ship-to-underwater (ASW)

STATUS: Operatianal

PRIME CONTRACTOR: Kangsberg Vapenfabrikk

PERFORMANCE: Range — mare than 3.5 mi.

DEPLOYMENT: Abaard Narwegian Navy vessels; U.S. and ather countries are evaluating.

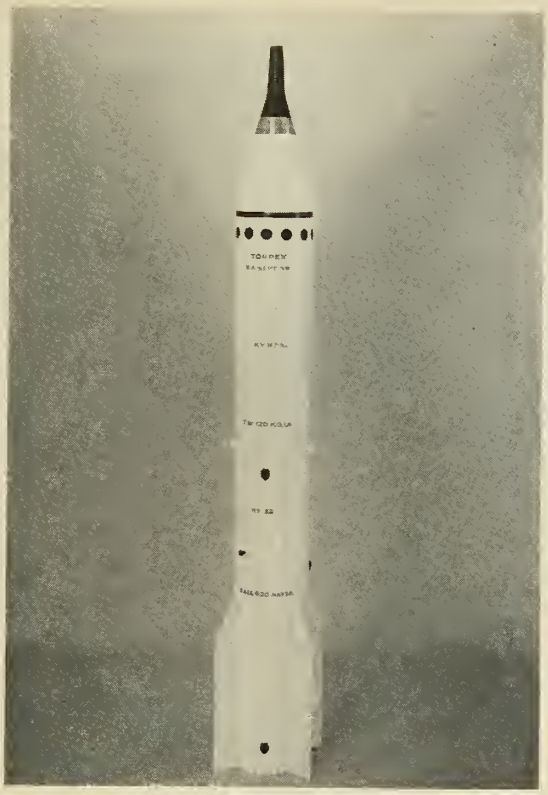
FRAME: *Length*—6.5 ft. *Diameter*—7.9 in. *System design:* Narwegian Defense Research Establishment

GUIDANCE: Cantained in attack sanar, fire cantral and launcher

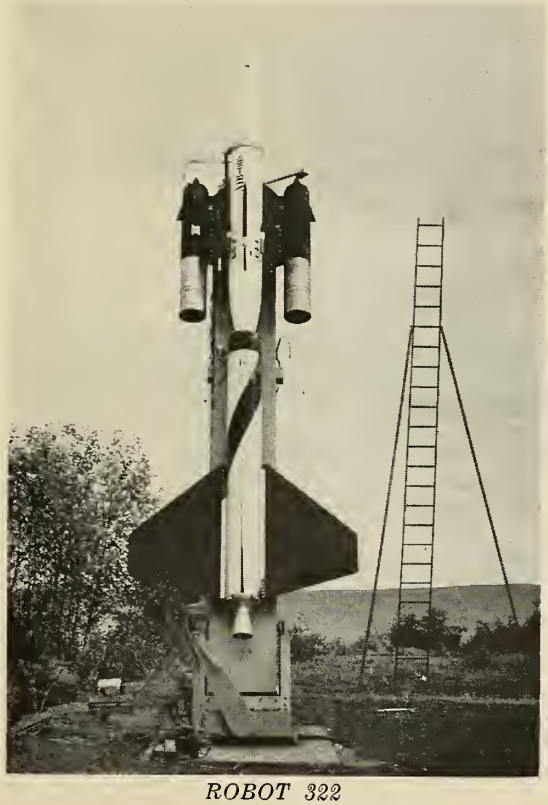
BOOSTER: *Type*—salid

PAYLOAD: *Type*—HE (105.6 lb. Mk 7 depth charge)

REMARKS: Launcher can fire 6 missiles in 5 secs.



TERNE



ROBOT 322

ITALY

AIRONE (Army)

TYPE: Surface-ta-surface (tactical)

STATUS: Operatianal

PRIME CONTRACTOR: Palverificia Giavanni Stacchini

PERFORMANCE: *Range*—6 miles.

GUIDANCE: *Type*—free.

BOOSTER: *Type*—salid.

C-7 (Air Force)

TYPE: Air-ta-air

STATUS: In praductian

PRIME CONTRACTOR: Sacieta Italiana Sviluppa Propulsiane a Reaziane (awned by Fiat and Finmercanica)

PERFORMANCE: *Range*—6 miles. *Speed*—Mach 1.9.

DEPLOYMENT: *Location*—abaard Italian Air Farce interceptars.

FRAME: *Length*—6.5 ft. *Wingspan*—25 in. *Diameter*—6 in. *Launch weight*—155 lbs.

GUIDANCE: *Type*—infrared.

BOOSTER: *System contractar*—Thiakal. *Type*—salid.

PAYLOAD: *Warhead type*—HE (55 lbs.)

REMARKS: New madels have alternate radar guidance and Bambrini Paradi-Delfina baaster.

SWEDEN

ROBOT 322 (Army)

TYPE: Surface-ta-air

STATUS: R&D

PRIME CONTRACTOR: Swedish Guided Missile Bureau and Rayal Swedish Armed Farces Research Establishment

BOOSTER: *Type*—salid

SUSTAINER: *Type*—twin ramjets

BANTAM (Army)

TYPE: Surface-ta-surface (anti-tank)

PRIME CONTRACTOR: A. B. Bafars

STATUS: Operatianal

PERFORMANCE: *Range*—6500 ft. *Speed*—190 mph.

DEPLOYMENT: *Location* — with Swedish cambat traaps.

FRAME: *Length*—2.5 ft. *Launch weight*—13 lbs.

GUIDANCE: *Type*—wire.

BOOSTER: *Type*—salid.

SUSTAINER: *Type*—salid.

PAYLOAD: *Warhead type* — HE (3.1 lbs.).

REMARKS: Bantam can be fired fram an infantryman's hip.

ROBOT 304 (Air Force)

TYPE: Air-to-surface

STATUS: Operational

PRIME CONTRACTOR: Swedish Guided Weapons Bureau and Royal Swedish Armed Forces Research Establishment.

PERFORMANCE: Range—about 3 miles. *Speed*—Mach 1.

DEPLOYMENT: *Location*—Swedish Air Force.

FRAME: *Length*—14.5 ft. *Launch weight*—1000 lbs.

GUIDANCE: *Type* — radio command.

BOOSTER: *Type*—solid.

PAYLOAD: *Warhead type*—HE.

REMARKS: Designed for use against naval targets.

ROBOT 315 (Navy)

TYPE: Surface-to-surface (tactical)

STATUS: Operational

PRIME CONTRACTOR: Swedish Guided Missile Bureau and Royal Swedish Armed Forces Research Establishment

PERFORMANCE: *Range*—10 to 20 n. miles. Speed—Mach .9.

DEPLOYMENT: *Location*—aboard Swedish Destroyers Halland and Smaland.

FRAME: *Length*—24 ft. *Launch weight*—3000 lbs.

GUIDANCE: *Type*—not available.

BOOSTER: *Type*—solid (4).

SUSTAINER: *Type*—pulsejet.

PAYLOAD: *Warhead type*—HE.

REMARKS: Torpedoboat model known as Sjarobat.

FRIDA, GERDA (Air Force)

TYPE: Air-to-air

STATUS: Operational on Saab, Lansen and Draken aircraft

PRIME CONTRACTOR: *Armament*—Bofors A.B. *Fire Control*—Saab

PERFORMANCE: Frida has 2624 ft./sec. velocity at 32,000 ft. with .9 sec. burning time. Gerda is an improved version

REMARKS: Adam is an air-to-surface version of the same missile used for strafing. It is about 6 ft. in length, 5 5/16 in. in diameter and weighs 90.4 lbs.—including a 39.7-lb. HE warhead

ERIKA (Navy)

TYPE: Ship to underwater

STATUS: Evaluation

PRIME CONTRACTOR: Bofors A.B.

PERFORMANCE: *Max. range*—more than 1 mi. at 170-ft. depth

FRAME: *Length*—6.7 ft. *Weight*—550 lbs.

PAYLOAD: *Warhead type*—HE (wgt. 220 lbs.)



MOSQUITO

ARGENTINA

A3H (Air Force and Navy)

TYPE: Air-to-surface

STATUS: Operational

PERFORMANCE: Range — 3.8 miles.

FRAME: *Length*—about 3 ft. *Diameter* — about 4 in. *Launch weight*—48 lbs. *Material (major)*—steel.

GUIDANCE: *Type*—free.

BOOSTER: *Type*—solid.

PAYLOAD: *Warhead type*—HE.

PAT-1 (Air Force)

TYPE: Air-to-surface

STATUS: R&D

PERFORMANCE: Range — about 12 miles.

FRAME: *Length* — about 11 ft. *Diameter*—about 1 ft. *Launch weight*—2310 lbs. *Material (major)*—steel.

BOOSTER: *Type*—liquid. *Propellant*—oxygen and methanol.

PSR-1 (Army)

TYPE: Surface-to-surface (antitank)

STATUS: R&D

FRAME: *Length*—3.8 ft. *Launch weight*—19.5 lbs.

BOOSTER: *Type*—Solid (1).

PAYLOAD: *Warhead type*—HE.

REMARKS: Can be launched by one man.



PSR-1

AUSTRALIA

MALKARA (Army)

TYPE: Surface-to-surface (antitank). Also effective against bunker fortifications.

STATUS: Operational

PRIME CONTRACTOR: Government Aircraft Factories

PERFORMANCE: Range—about 2 miles.

DEPLOYMENT: *Location* — British combat troops.

FRAME: *Length*—6.5 ft. *Wingspan*—2.5 ft. *Launch weight*—206 lbs.

GUIDANCE: *Type*—wire.

BOOSTER: *Type*—solid.

SUSTAINER: *Type*—solid.

PAYLOAD: *Warhead type* — HE (55 lbs.).

SWITZERLAND

RSD-58

TYPE: Surface-to-air

STATUS: Operational

PRIME CONTRACTOR: Contraves AG and Oerlikon Machine Taal Works Buhrle & Co.

PERFORMANCE: Range — 18.6 miles. *Speed*—Mach 2.5. *Ceiling*—65,000 ft.

DEPLOYMENT: *Location*—Training units in Italy and Japan.

FRAME: *Length*—20 ft. *Launch weight*—about 900 lbs.

GUIDANCE: *System contractor*—Brawn, Baveri & Co. *Type*—beam rider.

BOOSTER: *Type*—liquid.

PAYLOAD: *Warhead type*—HE.

REMARKS: RSA-54 is an earlier model. RSC-57 is a training model. New solid version with improved guidance under development.

MOSQUITO (Army)

TYPE: Surface-to-surface (antitank)

STATUS: Operational

PRIME CONTRACTOR: Contraves AG and Oerlikon Machine Tool Works Buhrle & Co.

PERFORMANCE: *Range* — about 6200 ft. *Speed*—200 mph.

DEPLOYMENT: *Location* — Swiss Army units.

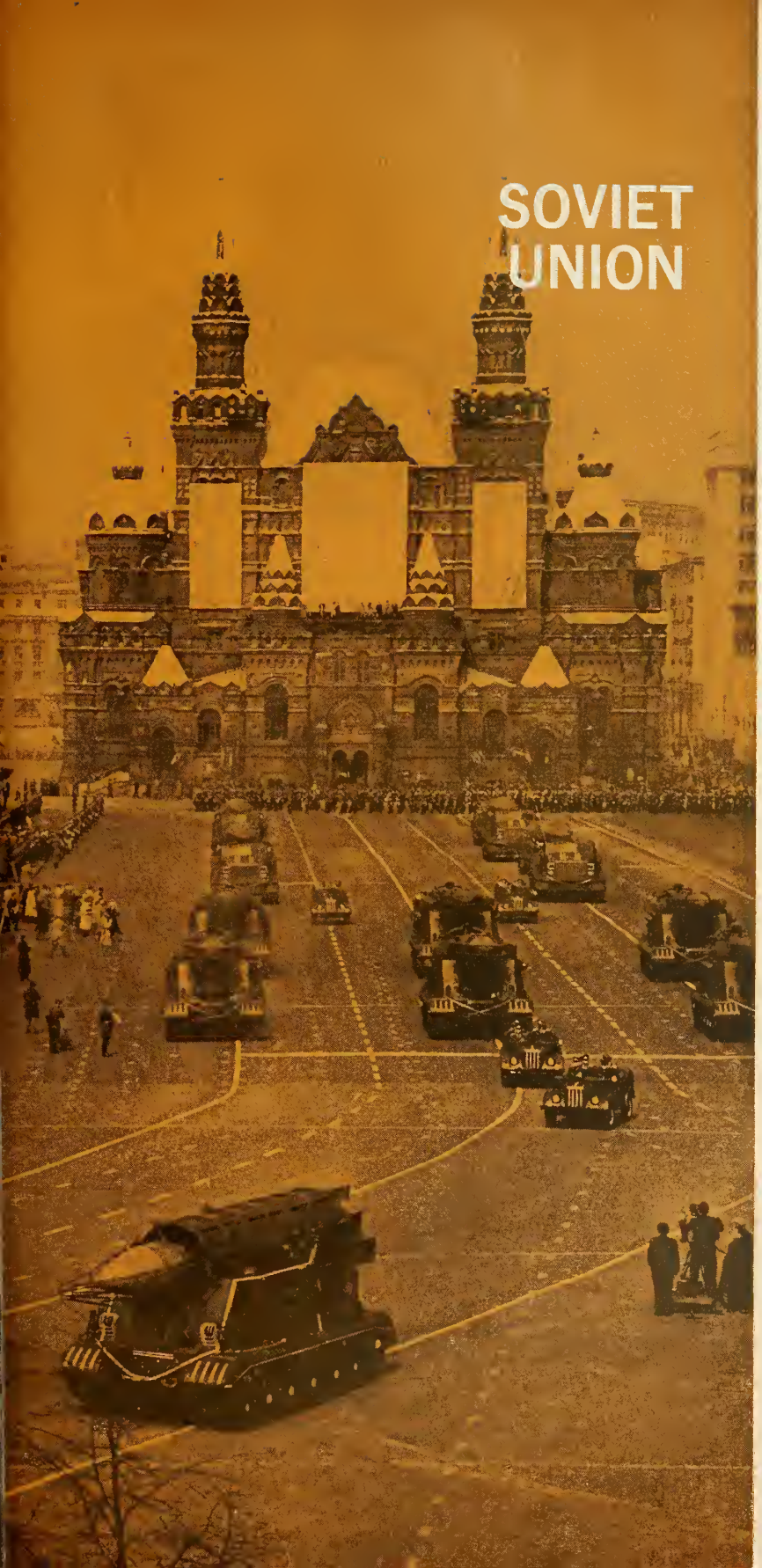
FRAME: *Length* — 3 ft. *Launch weight*—23 lbs.

GUIDANCE: *Type*—wire.

BOOSTER: *Type*—solid.

SUSTAINER: *Type*—solid.

PAYLOAD: *Warhead type*—HE (7 lbs.).



GOLEM 1 (Navy)

TYPE: Surface-to-surface

STATUS: Neor operational

PERFORMANCE: *Ronge* — 400 miles; *Altitude*—125 miles.

FRAME: *Length*—54 ft.; *Weight*—16½ tons grass; single stage.

REMARKS: Developed from German Warld Wor II plans for a sea-going V-2 (A-3). Liquid-fueled, rodio-inertial guided. Designed to be launched from o copsule towed by a submorine. Nuclear copobility.

GOLEM II (Navy)

TYPE: Underwater-to-surfoce

STATUS: RD&T

PERFORMANCE: *Range* — 1200-1300 miles.

FRAME: *Length*—neorly 60 ft.

REMARKS: Advanced versian of the Golem I with improvements odapted from the Army T-2. Probably rodio-inertial guided, liquid fueled. Nuclear capability.

GOLEM III (Navy)

TYPE: Underwoter-to-air, surface-to-air

STATUS: Operational on surface vessels

PERFORMANCE: *Range*—10 miles.

FRAME: *Length*—15 to 20 ft.; *Diameter*—20 in.

REMARKS: Salid-fueled, infrared-guided. Designed to give bath submarines and surface ships anti-aircraft protection.

GOLEM IV (Navy)

TYPE: Surface-to-oir

STATUS: Operational on surface vessels

PERFORMANCE: *Range*—45 miles.

REMARKS: A new missile, rodar-guided ond solid-fueled. May alsa be converted to submorine use.

J-3 (Navy and Army)

TYPE: Surface-to-surface

STATUS: Operotional with the Red Army ond ot leost 7 Baltic fleet cruisers.

PERFORMANCE: *Range*—450-600 miles; *Speed*—supersanic.

FRAME: *Length*—36 ft.

REMARKS: Booster is cluster of 4 solid-fuel rockets; ramjet sustainer. Guidance presumably is beam-riding or progromed. Nuclear copability.



T-1 (Army)

TYPE: Surface-to-surface
STATUS: Operational
PERFORMANCE: *Range*—600-775 miles
FRAME: *Length*—50 ft.; *Weight*—19 tons gross; single stage
REMARKS: Mobile IRBM. LOX/hyrocarban fueled booster generotes 77,000 lbs. thrust. Radio-guided. Nuclear capability.

T-2 (Army)

TYPE: Surface-to-surface
STATUS: Operational
PERFORMANCE: *Range* — 1300-1500 miles; *Speed*—5000 m.p.h.
FRAME: *Length*—between 85 and 91 ft.; *Weight*—55 tons; two stages.
REMARKS: Liquid-fueled, 80,000 lb. thrust booster. The T-2 reportedly was the first Soviet rocket used to test an H-bomb warhead. Fired from Central Russia, the warhead was exploded at 120,000 ft. near Bennet Island in the Arctic.

T-3 (Air Force)

TYPE: Surface-to-surface
STATUS: Operational
PERFORMANCE: *Range* — 5000 miles; *Speed*—15,000 m.p.h.; *Apagee*—280 miles.
FRAME: Two stages.
REMARKS: Liquid-fueled with booster developing 500,000 lbs. thrust. Radio-inertial-guided. HE or nuclear warhead. Russia reportedly produced 50 T-3's in 1959 and has capability to build 1200 by the end of 1963.

T-3A (Army)

TYPE: Surface-to-surface ICBM
STATUS: Operational
PERFORMANCE: *Range (Model A)*—6000 miles; *Range (Model B)*—7500 miles; *Speed*—15,000 m.p.h.
FRAME: Model A—2 stages; Model B—3 stages
POWERPLANT: Liquid-fueled. *Model A first stage*—525,000 lbs. of thrust; *Model B first stage*—700,000 lbs. of thrust.
REMARKS: Production of the Model A is believed to have ceased in recent months in favor of the advanced version. Original production plans reportedly called for an equal number of T-3A Model A's and T-3's. The new booster stage on the Model B is believed to be a prototype for one used in the T-4A antipadal missile. Nuclear warhead.

T-4 (Army)

TYPE: Surface-to-surface IRBM
STATUS: Experimental
PERFORMANCE: *Range* — 1000 miles.
POWERPLANT: Two stages, both liquid-fueled.
FRAME: *Length*—53 ft.
REMARKS: 1800-lb. payload may be either nuclear or HE. Some of its configurations are believed to be worked into upper stages of the T-4A.

T-4A (Air Force)

TYPE: Surface-to-surface antipodal missile
STATUS: Advanced RDT&E
PERFORMANCE: *Range* — 10,000 miles; *Apagee* — 186.3 miles; *Speed*—13,660 m.p.h.
FRAME: *Length*—121.02 ft.; *Wing span*—65.6 ft.; *Max. Diameter*—6.88 ft.; *Launch weight*—115 tons.
(Continued top of next column)
POWERPLANT: First stage has 3 LOX/kerosene engines developing 360,000 lbs. thrust.
REMARKS: Catapulted from rail sled. Payload—2350 to 3100 lbs. This is the Soviet counterpart of the U.S. Dyna-Soar boost-glide bomber, stemming from the German Saenger-Bredt design conceived in World War II.

T-5 (Army)

TYPE: Surface-to-surface
STATUS: Operational with Red Army in Eastern Europe
PERFORMANCE: *Range* — 50-100 miles.
FRAME: *Length*—about 36 ft.; 3 stages (advanced version may have 4 stages).
POWERPLANT: Solid-fueled.
REMARKS: Designed for firing from multiple launchers for blitz-type saturation of target. HE or small nuclear warhead.

T-5A (Army)

TYPE: Surface-to-surface IRBM
STATUS: Operational
REMARKS: Few details are available. Believed to be solid-fueled and guided.

T-5B (Army)

TYPE: Surface-to-surface
STATUS: Operational (but out of production)
PERFORMANCE: *Range* — 15-25 miles
FRAME: *Length*—31 ft.; *Diameter*—3 ft.; *Weight*—6000 lbs.
REMARKS: Similar to the U.S. Honest John. Launched from tracked vehicle. Unguided. Carries HE and possibly a nuclear warhead.





T-6 (Army)

TYPE: Surface-to-air

STATUS: Operational

PERFORMANCE: Range — 20-25 miles; *Speed*—1500 mph; *Ceiling*—about 60,000 ft.

FRAME: 2 stages

WARHEAD: HE with proximity fuze.

POWERPLANT: Solid fueled with cluster of 4 solid boosters.

REMARKS: Fired from multiple launcher. An advanced version, the T-6A, is radar guided and believed to be operational.

T-7A (Army)

TYPE: Surface-to-surface

STATUS: Operational

PERFORMANCE: Range—50 to 90 miles; *Speed*—Mach 5; radio command guidance.

FRAME: *Length*—30 ft.; *Diameter*—2.5 ft.; *Weight*—about 10,000 lbs.

POWERPLANT: Solid fueled

WARHEAD: HE

REMARKS: Has controllable rear fins.

T-8 (Army-Air Force)

TYPE: Surface-to-air (also air-to-air)

STATUS: Operational

PERFORMANCE: Range—15 to 25 miles; *Speed*—Mach 2.5

FRAME: *Length*—13 ft.; two stages

POWERPLANT: First stage is cluster of two solid fueled boosters, second stage is liquid fueled.

WARHEAD: HE with proximity fuze.

T-33 (Army)

TYPE: Surface-to-surface ICBM

REMARKS: A new missile. No other details available.

KCAT-25 (Army)

TYPE: Antitank

REMARKS: Never exhibited, believed to be operational.

KOMET I (Navy—CH 17 Army)

TYPE: Surface-to-surface

PERFORMANCE: Range — 100 miles; *Speed*—3000 m.p.h.

REMARKS: Solid-fueled, the CH17 is reported to be operational with the Red Army. A crash program is underway to put the Comet I into service aboard submarines and surface ships. HE and nuclear warheads.

KOMET II (Navy—CH 18 Army)

TYPE: Surface-to-surface

PERFORMANCE: Range — 600 miles.

REMARKS: Operational with the Red Army and from a surface vessel in calm waters. Crash program in progress with ship motion simulator equipment; R&D for submarines. Solid-fueled, nuclear warhead.

KOMET D (Air Force)

TYPE: Air-to-surface standoff

STATUS: In development and test

PERFORMANCE: *Range*—55 miles.

FRAME: *Length*—33.5 ft.; *Diameter*—about 4 ft.

REMARKS: An equivalent to the British Avro, the turbojet-propelled missile may have beam-riding guidance. Warhead can be either nuclear or HE.

M-2 (Army-Navy)

TYPE: Anti-aircraft

STATUS: Operational with ground defense forces and aboard Baltic Sea cruisers.

PERFORMANCE: *Speed*—Mach 2.

FRAME: *Length*—about 25 ft.; 2 stages.

REMARKS: Solid-fueled. Infrared, radar, or both used as guidance.

M-100A (Air Force)

TYPE: Air-to-air

STATUS: Operational

PERFORMANCE: Range — 3½ miles; *Speed*—Mach 2.5

REMARKS: Solid-fueled, semi-active radio-radar command guidance.

ME-IGOR (Army)

TYPE: Antitank

FRAME: *Length*—24 in.; *Diameter*—3 in.

REMARKS: Solid-fueled. Fired from bazooka tube. Was operational, but probably used now only for training.

RS-82, RS-132, RS-132A (Air Force)

TYPE: Air-to-air

FRAME: *Length*—unavailable; *Diameter*—5.2 in.

REMARKS: Aircraft version of the GVAI. Used for training.

GVAI (Army)

TYPE: Barrage rocket

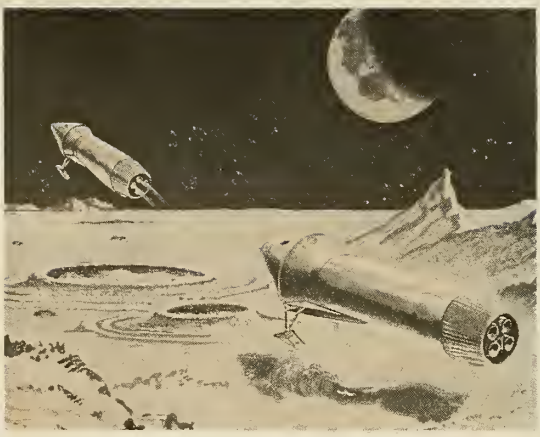
REMARKS: Multiple-tube launcher, fired in salvoes. May be phased out for more advanced versions.


SPACE
SYSTEMS

A multibillion-dollar U.S. space program is under way in support of the U.S. decision to race Russia to landing a man on the moon.

Military goals in space, however, remained to be clarified. The civilian NASA is handling the lunar mission with Apollo—a follow-on to Mercury. Congress has urged a speed-up in the Air Force's Dyna-Soar, fearing Soviet dominance close to earth following the orbiting of Russian Major Yuri Gagarin on April 12, 1961.

Most difficult hurdle for U.S. is to close the "booster gap."



APOLLO LUNAR LANDING

SPACECRAFT

APOLLO (NASA)

TYPE: Three-man spacecraft

STATUS: R&D

PRIME CONTRACTOR: Convair, General Electric, Martin engaged in feasibility studies.

MISSION: Place manned spacecraft in lunar orbit and return to earth; earth orbiting flights, lunar landings.

FRAME: Ballistic capsule with lifting surfaces.

BOOSTER: Saturn and/ar Nova.

REMARKS: First manned flight scheduled for 1964-65.

DYNA-SOAR (Air Force)

TYPE: Manned boost-glide spacecraft

STATUS: R&D

PRIME CONTRACTOR: Boeing Co.

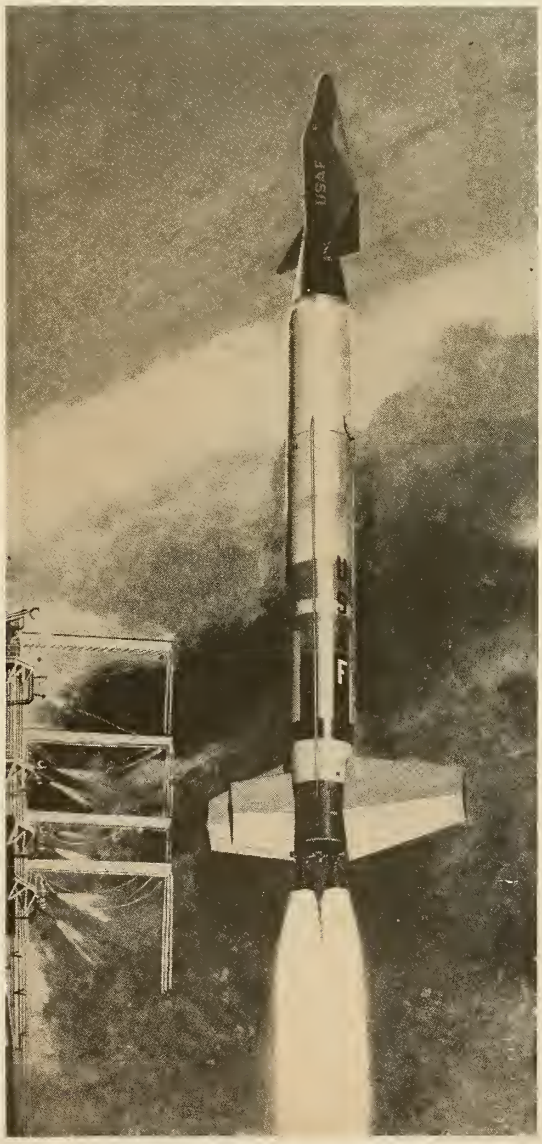
MISSION: Determine feasibility of orbital bomber

FRAME: *System cantractar*—Boeing; *System manager*—Aeronautical Systems Div., Air Force Systems Command. *Canfiguratian*—delta-winged glider. *Weight*—about 10,000 lbs. subarbital, up to 20,000 lbs. orbital.

BOOSTER: *System cantractar*—Martin. *Type*—modified Titan II far subarbital version; Saturn for orbital.

POWER UNITS: *System cantractar far accessary pawer unit*—Sundstrand Corp. *Type*—gaseous hydrogen-axygen unit.

REMARKS: The program funded through FY '62 at abaut $300 million tatal. Expected ta be redirected and accelerated to achieve suborbital flight 1963-64; first arbital flight 1964-65.



DYNA-SOAR ON TITAN II

←

THOR ABLE IV DEEP SPACE PROBE

missiles and rockets, July 17, 1961



X-15

ADVANCED SPACECRAFT

Name	Status	Contractar	Booster	Missian
BOSS (Air Farce)	Study	Lockheed, capsule, Gorrett Corp., life support system	Atlas-Agena-B	Bioastronauticol Orbiting Space Station to provide data on long-term weightlessness, rodiotion
GSS (Air Farce)	Study			Global Surveillance Station
MTSS (Air Farce)	Study			Military Test Spoce Station
SMART (Air Farce)	Study			Spoce Maintenance ond Repair Techniques
SLOMAR (Air Farce)	Study			Space Logistics, Maintenance and Repair
YO YO (Navy)	R&D	Na contract announced		Tactical sea-lounched one-pass reconnaissance sotellaid



MERCURY-ATLAS

MERCURY (NASA)

TYPE: Manned earth orbiting spacecraft

PRIME CONTRACTOR: McDonnell Aircroft Co.

MISSION: Orbit at about 120 miles oltitude. In two flights in 1961 carried chimponzee "Ham" and astronaut Alon Shepard in sub-orbital flights

FRAME: *System* contractar—McDonnell. *Length*—9.5-ft. *Diameter*—6.5-ft. *Weight*—about 2000-lbs. Totol weight of capsule obave booster is 4400-lbs.

INSTRUMENTATION: *System* contractar—McDonnell. Types onc functians — physio-psychological attitude, navigatian.

BOOSTER: *System* contractors—Chrysler, Redstane ond Canvai Atlas. *Propellant*—liquid.

POWER UNITS: *System* contracto —McDonnell. *Type*—battery. *Lif* —mission plus 12 hours. *Outpu* —(6) 1500 watt/hour batteries

REMARKS: Manned orbital fligh scheduled before the end af 1961

X-15 (Air Force-Navy-NASA)

TYPE: Manned R&D racket plane

STATUS: R&D flight testing

PRIME CONTRACTOR: Narth Americon Aviotion, Inc.

MISSION: *Range*—400 n. miles. *Speed*—4000 mph. *Ceiling*—50-100 miles.

FRAME: *System* contractar—North American. *Length*—50-ft. *Launch weight*—31,275-lbs. *Landing weight*—12,971 lbs. *Wingspon*—22 ft.

BOOSTER: *System* contractar—Thiokol. *Propellant* — LOX an liquid ammonio. *Thrust*—57,00 lbs. *Type*—XLR99

POWER UNITS: *System* contracto —Generol Electric

REMARKS: The X-15 program oimed at exploration af the atma phere at the fringes of space.

AEROSPACE PLANE (Air Force)

TYPE: Air-space weopan system

STATUS: Study & R&D

PRIME CONTRACTOR: Nane

MISSION: Orbital bombing; rendezvous with space statians

REMARKS: ASP would toke o from B-52 runway on rock power and refuel in upper a mosphere by liquefying axyge for its LOX/LH_2 engine. A Force estimotes thot craft coul be develaped about 1970.

VOYAGER (NASA)

TYPE: Unmonned interplanetary spocecroft

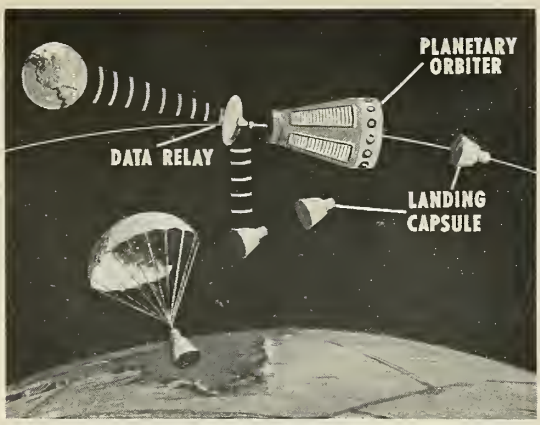
STATUS: Study

PRIME CONTRACTOR: None owarded

MISSION: 2400-lb. spacecraft ta arbit Venus and Mars and eject 700-lb. capsule far ground exploration.

BOOSTER: Saturn

REMARKS: First flight planned in 1967



VOYAGER

MARINER (NASA)

TYPE: Interplanetory probe

STATUS: Engineering models under construction

PRIME CONTRACTOR: JPL

MISSION: 600-1200-lb. spacecraft for Venus and Mars flyby explorotion

FRAME: Similor to Ranger

INSTRUMENTATION: Radiatian and magnetic field experiments, radiometer ond spectrometer

BOOSTER: Atlos-Ageno B, then Centaur

POWER UNITS: Power supply system will include solar cell panels.

REMARKS: First launch scheduled for August, 1962.

PROSPECTOR (NASA)

TYPE: Lunor soft-landing spacecroft

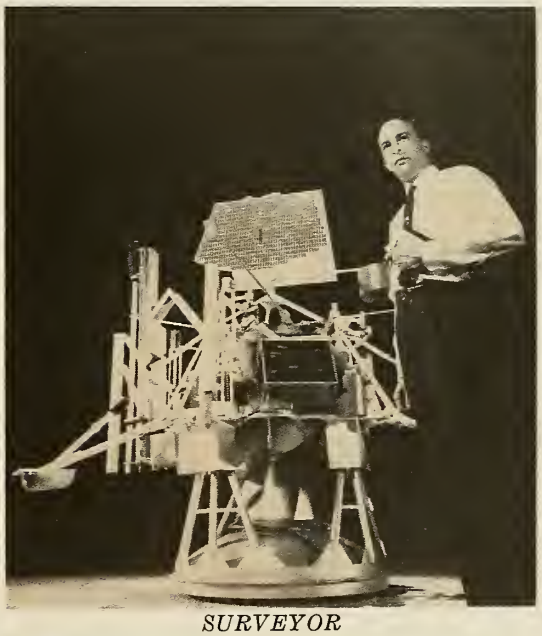
STATUS: R&D

PRIME CONTRACTOR: None announced

MISSION: Land instruments far exploratian and mapping of moon. Alsa possible return af lunor surfoce samples.

BOOSTER: Saturn

REMARKS: First flights to begin in 1966-70 time period.



SURVEYOR

SURVEYOR (NASA)

TYPE: Lunor soft-londing spacecroft.

PRIME CONTRACTOR: Hughes Aircroft.

MISSION: Soft land 750-lb. copsule on surfoce of moon.

INSTRUMENTATION: Copsule will contain 250-lbs. af scientific instruments: Sterox color television cameros, spectrometer, lunar surface drill.

BOOSTER: Atlas-Centaur

POWER UNITS: Power supply will include solar cells

REMARKS: Seven lounchings to begin in 1963.



RANGER

RANGER (NASA)

TYPE: Lunar impoct spocecraft

STATUS: R&D

PRIME CONTRACTOR: JPL, prime. Aeronutronic, capsule. Hercules, retrorocket.

MISSION: 300-lb. instrumented copsule rough-landed on the moon.

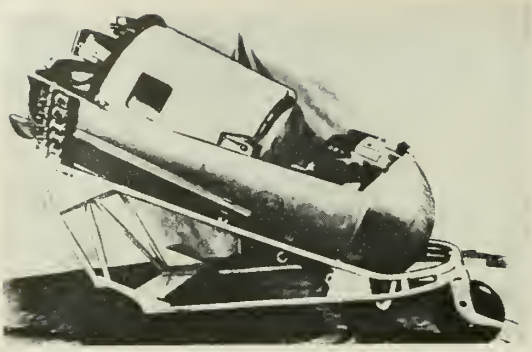
FRAME: Vories with mission.

INSTRUMENTATION: Rubidium vapor mognetometer, Lyman Alpha telescope, Zero db antenna.

BOOSTER: Atlas-Agena B.

POWER UNITS: Solar cells.

REMARKS: Five flights scheduled to begin in 1961. Landing an moon scheduled for 1962.



COSMIC SHIP II

VOSTOK (Russia)

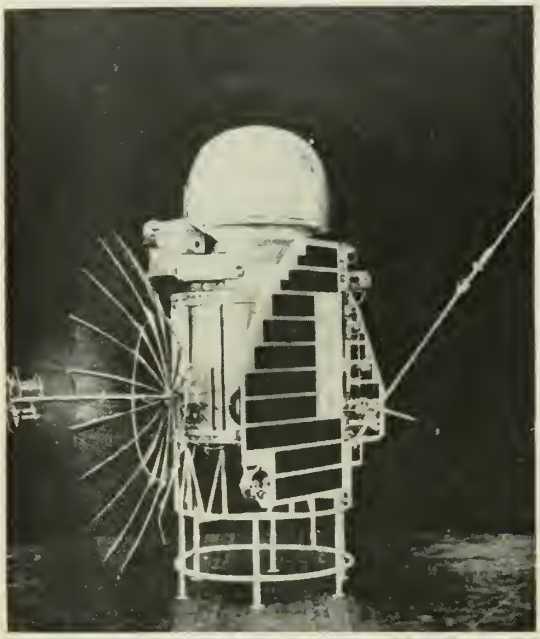
TYPE: One-man spacecraft

MISSION: Orbital space flight

FRAME: Believed to be 20 ft. long. Probably winged. Paylood weight 10,418 lbs.

INSTRUMENTATION: Radia and TV equipment relaying dato on condition of man oboard; life-suppart equipment reported co-pable of sustaining man 10 doys.

REMARKS: Launched with Majar Yuri Gogorin oboard April 12, 1961 and recovered after one pass around the earth.



VENUS PROBE

SPUTNIKS IX AND X (Russia)

TYPE: Orbital spocecroft

MISSION: Experiments leoding to monned space flight. USSR on-nounced successful re-entry ond recovery of both copsules. Sput-nik IX launched ond re-entered Mor. 9, 1961 ond Sputnik X launched and reentered Mar. 25, 1961.

INSTRUMENTATION: Radio and TV equipment reloying dota an onimols oboord.

REMARKS: Cobins recovered in predetermined locotions in USSR, with onimols reported olive. Sput-nik IX soid to hove corried 13-lb. dog, guineo pigs, block mice, in-sects ond seeds of severol plonts; Sputnik X, one dog ond other onimals.

VENUS PROBE (Russia)

STATUS: Last radia contoct severol days ofter lounch from orbiting Sputnik VIII. Sputnik down an Feb. 25. Pawer supplied by chem-ical sources chorged by solor bat-teries.

MISSION: Orbit sun, flying by ar impacting Venus. *Aphelian*—1.0684 ostronomicol units. *Peri-helion*—0.7104 ou

FRAME: 80-in. long, 41-in. diom-eter without ontennos ond solar paddles, 1419 lbs. Weight of Sputnik not disclosed.

INSTRUMENTATION: Meosure cos-mic rays, magnetic fields, charged particles of interplonetary gos ond corpusculor sunbeoms; record micrometeor impacts; temp. con-trol; telemetry; oltitude control and stabilization systems.

DEEP SPACE PROBES

Name and Country	Weight (lbs.)	Launch Vehicle	Launch Date	Trajectary and Purpase	Remarks
LUNIK I (MECHTA), RUSSIA	3245	N.A.	1/ 2/59	Escape eorth in direction of moon	In 450-doy solor orbit; passed within 5000 miles of moon
PIONEER IV, U.S.	13.4	JUNO II	3/ 3/59	Escape earth in direction of moon	In solar orbit of 398 days; passed within 35,000 miles of moon
LUNIK II, RUSSIA	780 (incl. final stage)	N.A.	9/12/59	Lunar impact; rodiation and magnet-ism measurements	Achieved impact
LUNIK III, RUSSIA	Abaut 614	N.A.	10/ 4/59	Eorth-moon orbit, apogee 291,000 mi., perigee 30,000 mi., very long lifetime	Took first picture of far side of moon. Not in orbit.
PIONEER V, U.S.	94.8	THOR-ABLE	3/11/60	Solar orbit between Eorth ond Venus orbits; long-ronge radio communico-tions; radiotion, spoce environment measurements	Transmitted data more than 20 mil-lion miles. No langer transmitting.
VENUS PROBE	1419	Multi-stage	2/12/61	Test methods of injecting probe into interplanetory trojectory; test long-range communicotions	Probe lounched from Sputnik VIII while in orbit

BOOSTERS

CENTAUR (NASA)

TYPE: Multipurpose launch vehicle.

STATUS: R&D

PRIME CONTRACTOR: Canvair.

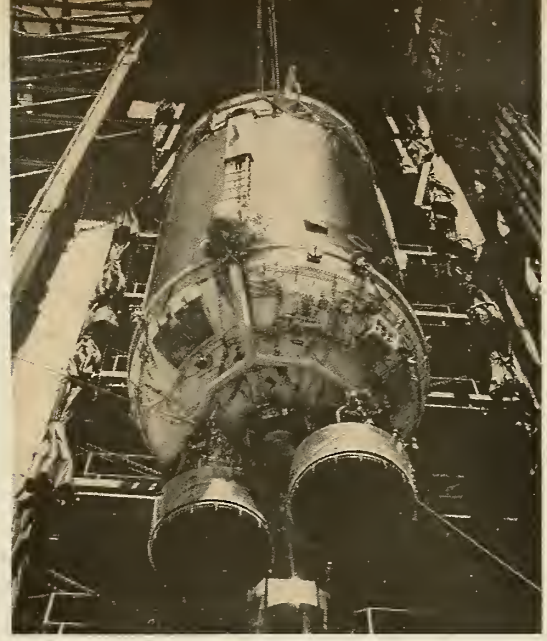
PERFORMANCE: 300-mile orbit—8500 lbs. *Escape velacity*—2500 lbs.

FRAME: *Length overall*—105 ft. *Diameter*—10 ft. *Grass weight*—291,000 lbs. *Major materials*—steel, aluminum.

STAGES: 1. Modified Atlas ICBM. 2. Centaur. *Manufacturer*—Convair; *engines*—Pratt & Whitney LR-115 (2).

GUIDANCE: Minneapolis-Honeywell. *Type*—all-inertial.

REMARKS: First flight 1961. Will provide for the first time U.S. lift capacity equal to Sputnik I and will be most powerful U.S. vehicle until Saturn is available.



CENTAUR

THOR-AGENA (Air Force and NASA)

TYPE: Launch vehicle

STATUS: Operational with Agena A. R&D with Agena B.

PRIME CONTRACTOR: None

PERFORMANCE: *Agena A*—300 lbs. in 300-mile orbit. *Agena B*—1600 lbs. in 300-mile arbit.

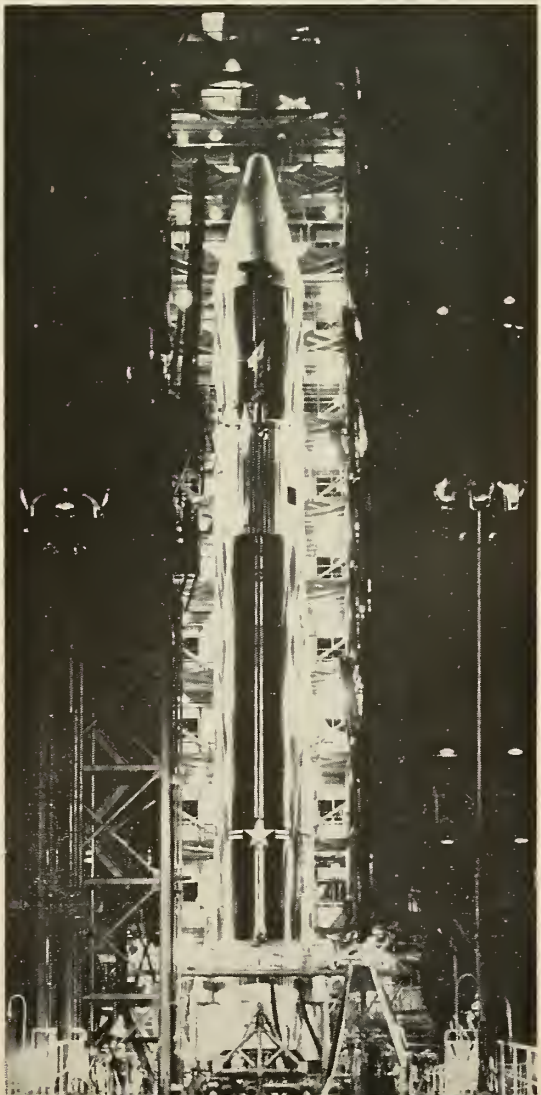
FRAME: *Manufacturers*—Douglas, Lockheed. *Length overall*—Agena A 78.6 ft., Agena B 86 ft. *Diameter*—8 ft. *Gross weight*—Agena A 11B,500 lbs., Agena B about 123,000 lbs. *Major material*—aluminum

PROPULSION: All liquid.

GUIDANCE: (Only Agena B) Minneapolis-Honeywell. *Type:* All-inertial.

STAGES: 1. Madified Thor IRBM. 2. Agena. *Engine*—Bell XLR-81.

REMARKS: Thor-Agena A in use in Discoverer program. Thor-Agena B, with restartable upper stage, will be used by both Air Force and NASA beginning in 1961.



THOR DELTA, THOR ABLESTAR, THOR AGENA B

TYPE: Launch vehicle

STATUS: All operational.

PRIME CONTRACTOR: Dauglas for Delta and for Thor stages in other other two; Aerojet-General for Ablestar vehicle stage and Lockheed for Agena B vehicle stage.

PERFORMANCE: Payload in 300-mile arbit: *Delta*—500 lbs.; *Ablestar*—1000 lbs.; *Agena B*—1400 lbs.

FRAME: *Length overall*—Delta, 92 ft.; Ablestar, 79 ft.; Agena B, B1 ft.; *Diameter*—8 ft.; *Grass Weight*—Delta, 112,000 lbs.; Ablestar, 119,000 lbs.; Agena B, 123,000 lbs. *Major material*—aluminum.

PROPULSION: *Delta:* 2 liquid stages and one solid; *Ablestar* and *Agena B*, 2 liquid.

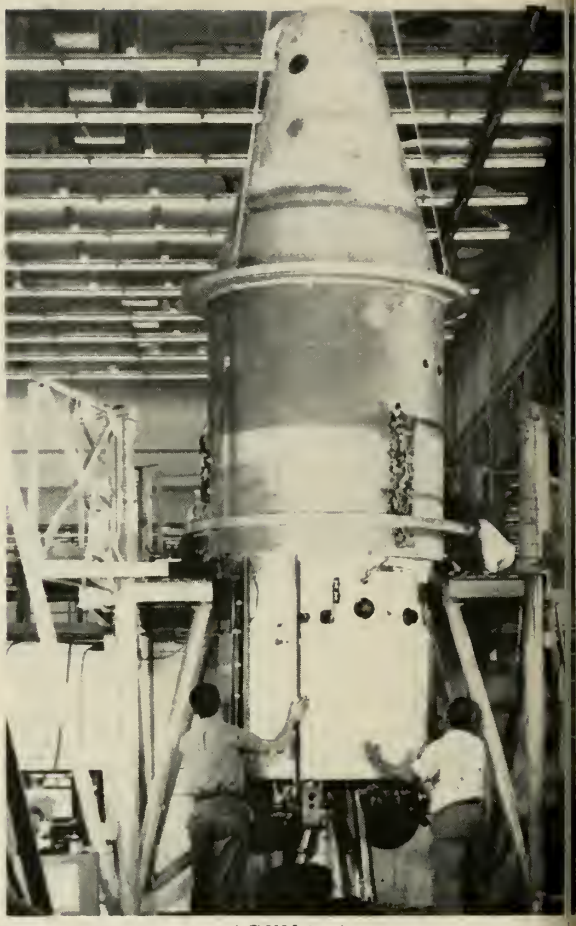
GUIDANCE: Delta, Bell Telephone; *Type*—radio command; *Thar Agena B*, Bell Telephone (first stage only); *Type:* radio command.

STAGES: 1. Modified Thar IRBM—MB3-1 on Delta; MB3-II—Ablestar and Agena B; 2. AJ-10-118—Ablestar, Agena B; 3. ABL Altair.

REMARKS: Delta has arbited the Echo I sphere, Tiros II and Explorer X satellites for NASA and is scheduled for use in Project Relay and such other NASA scientific satellites as S-3, S-6 and S-16. Its capabilities include a coast period prior to ignition of the third stage. Thor Ablestar, with a restartable, scaled-up Able, is used in the Navy's Transit program and was used for launching of Army's Caurier satellites; Thor Agena B is used in the Air Force Discoverer satellite program and will be used in NASA's Nimbus and rigidized Echo satellite projects and far launching NASA polar-orbiting geophysical observatory spacecraft.



SCOUT



AGENA A

SCOUT (NASA)

TYPE: Launch vehicle for small vehicles.

STATUS: R&D

PRIME CONTRACTOR: NASA Longley Research Center

PERFORMANCE: 300-*mile arbit*—obout 150 lbs.

FRAME: *Manufacturer* — Chance Vought. *Length overall*—72 ft. *Diameter*—40 in. *Gross weight*—36,100 lbs. *Major materials*—steel ond plostic.

PROPULSION: All solid

STAGES: 1. Aerojet Algol; 2. Thiakal Caster; 3. Hercules-ABL Antares; 4. Hercules-ABL Altair.

GUIDANCE: Minneapalis Honeywell. *Type*—semi-inertial.

REMARKS: Air Force has similar vehicle called Hyper-Environmental Test System 609A Blue Scout. Two complete vehicle tests from Wallops Island, Vo. One arbit of Explarer IX.

AGENA B (Air Force and NASA)

TYPE: Second-stage launch vehicle

STATUS: Operationol

PRIME CONTRACTOR: Lockheed

MISSION: Thar Agena B can lounch 1600-lb. spacecroft in low earth orbit. Used os launch vehicle for Air Force Discoverer Pragram. Atlas Ageno B can ploce 5000 lbs. in low earth orbit ar 750 lbs. on trojectary to the moan.

FRAME: *Height*—25 ft. *Diameter*—5 ft. *Weight*—15,550 lbs. with full propellont. Orbitol weight—2100 lbs.

STAGES: 1. Thor or Atlas. 2. Agena B—Bell XLR-81, Thrust—15,500 lbs.

REMARKS: Will be used by NASA for a variety af missions ond trajectories with first launching scheduled for mid-1961.

TITAN II (Air Force)

TYPE: Medium launch vehicle

STATUS: R&D

CONTRACTOR: *Prime* — Martin; *Guidance*—Aerojet-Generol.

MISSION: Space booster with thrust of up to 800,000 lbs.

PROPULSION: All Liquid.

GUIDANCE: Inertiol.

REMARKS: Shauld be aperational by eorly 1963. First launch, Nov. 1961. For the Dyna-Soar program, the Air Force plans to odd a solid-fuel acceleratar escape third stage.

ROVER (NASA-AEC)

TYPE: Nucleor rocket development program.

STATUS: R&D

PERFORMANCE: Super-thrust entions being conducted with Westinghouse ond Aerojet far development of NERVA, the first-generotion engine. Los Alomos Scientific Labaratory building and testing KIWI nucleor reoctor which will be used to develap reactor for engine.

PERFORMANCE: Super-thrust engine ta lift very heovy paylaads on interplanetary missions.

FRAME: Preliminory design contracts being negotiated with Lockheed, Martin, Convair and Douglos.

PROPELLANT: Liquid hydragen.

TOTAL WEIGHT: 39,000 lbs.

REACTOR POWER: 1000 megawotts thermol

THRUST (sea level): 52,000 lbs.

PROPULSION TIME: More than five minutes.

REMARKS: Power runs on reoctor KIWI-A conducted in 1959 ond 1960. Pawer runs on KIWI-B will be conducted through 1962. Reactar in flight test (RIFT) program will launch first NERVA engine in 1966-1967.

SATURN C-1 (NASA)

STATUS: R&D

PRIME CONTRACTOR. NASA Marshall Center

MISSION: 300-*mile arbit*—20,000-lbs. *Escape velocity*—5000-lbs.

FRAME: *Length overall (without payload)*—150 ft. *Diameter*—22 ft. *Grass weight*—1 millian lbs. *Major material*—aluminum

PROPULSION: All liquid

GUIDANCE: NASA Marshall Center. *Type*—all-inertial

STAGES. S1—Prime, Marshall Center. Engines—8 Racketdyne H-1. S-2—Prime, Douglas. Engines—6 Pratt & Whitney LR-115

REMARKS: First flight 1961 with dummy upper stages. First twa-stage vehicle flight in 1963. Operatianal 1964.

The Saturn pragram—which will include C-2 and C-3 vehicles—is the civilian space agency's "main chance" space vehicle in the internatianal space race. The Saturn vehicle in its later farms will be capable af sending a manned spacecraft araund the moan. It alsa will be capable af putting inta arbit araund the earth multi-tan segments af a space statian for assembly in space.

SATURN C-2 (NASA)

STATUS: R&D

PRIME CONTRACTOR: NASA Marshall Center

MISSION: 300-mile arbit—45,000 lbs. *Escape velacity*—15,000 lbs.

PROPULSION: All liquid

GUIDANCE: All inertial

STAGES: S-1 Boaster — Prime, NASA Marshall Center. Engines—8 Rocketdyne H-1. S-2 Na cantractor. Engines—4 Racket-dyne J2. S-4 Prime—Douglas. Engines—6 Pratt & Whitney LR-115. S-5 Prime—Douglas. Engines—2 Pratt & Whitney LR-115.

REMARKS: Under study far Apollo missians

SATURN C-3 (NASA)

STATUS: Study

PRIME CONTRACTOR: NASA Marshall Center

MISSION: 300-mile arbit. Law arbit—50 tans. *Escape velacity*—19 tans

GUIDANCE: All inertial

PROPULSION: All liquid

STAGES: S1 Engines—2 Racket-dyne F-1 (1.5 million lbs. thrust each). S2 Engines—4 J-2. S3 Prime—Douglas. Engine—6 Pratt & Whitney LR-115.

REMARKS: Canfiguratian under study by NASA as a heavy launch vehicle.

NOVA (NASA)

TYPE: Multimillian-lb.-thrust launch vehicle

STATUS: Study

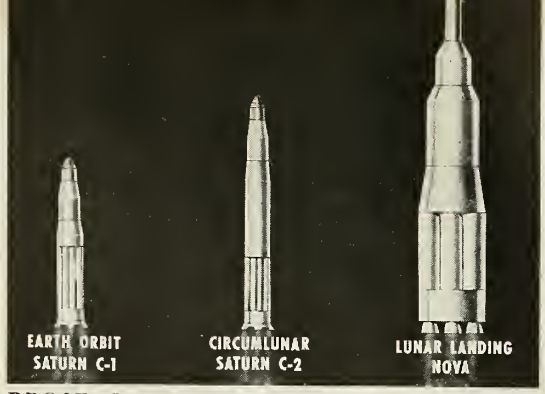
PRIME CONTRACTOR: Nat awarded

MISSION: Launch very heavy pay-laads in earth arbiting and lunar flights

STAGES: 1—8 Rocketdyne F-1 engines; 2—2 Racketdyne F-1 engines; 3—4 Rocketdyne J-2 engines, 4—6 Pratt & Whitney RL-10 engines, 5—2 Pratt & Whitney RL-10 engines

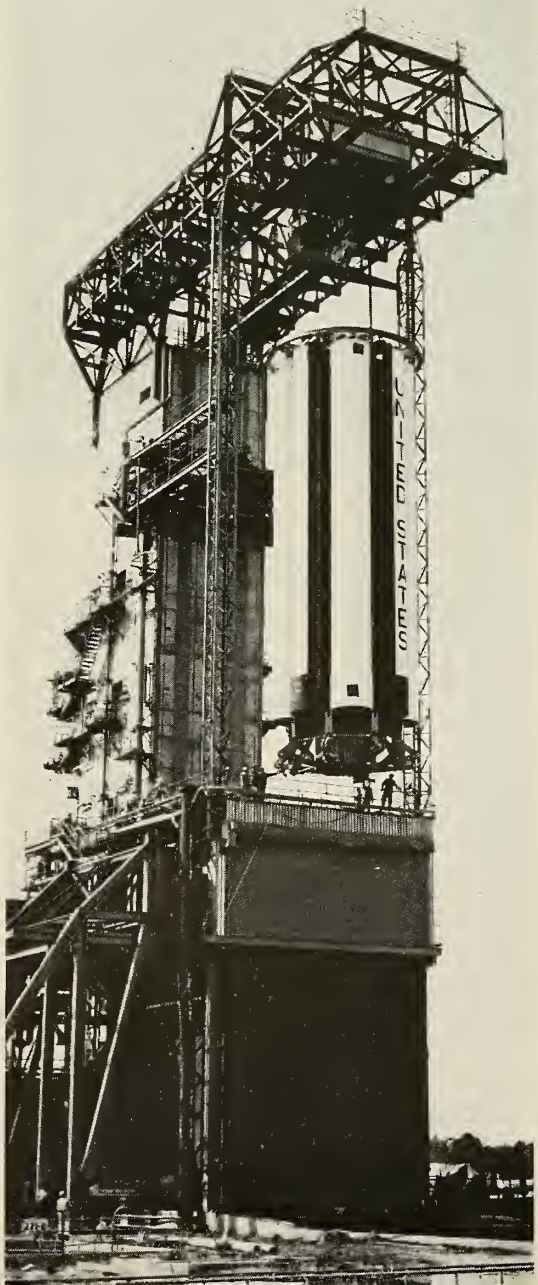
PROPULSION: All liquid in NASA versian

REMARKS: Air Farce is develaping a 2-3-million-lb.-thrust solid-prapellant Nava



PROJECT APOLLO LAUNCH VEHICLES

SATURN BOOSTER





TIROS II

SATELLITES

DISCOVERER (Air Force)

TYPE: Experimental military satellite series

STATUS: R&D

PRIME CONTRACTOR: Lockheed Aircraft Carp.

PERFORMANCE: *Orbit*—elliptical and varied (palar)

FRAME: *System contractor*—Lackheed. *Length*—19.2 ft. *Diameter*—5 ft. *Weight*—abaut 1700 lbs.

RE-ENTRY VEHICLE: *System contractor*—General Electric. *Type*—capsule. *Length*—27 in. *Diameter*—33 in. *Weight*—abaut 300 lbs.

INSTRUMENTATION: IR horizan scanner, telemetry, other instrumentatian varied.

BOOSTER: *System contractar*—Douglas. *Type*—Thar. *Propellant*—liquid.

SUSTAINER: *System contractor*—Lackheed. *Type*—Agena. *Propellant*—liquid.

REMARKS: The Discaverer pragram beginning early in 1959 has launched a series af R&D satellites inta arbit aimed at stabilization of a satellite in space and recovery of a capsule fram orbit. In 25 launchings 5 capsules were recovered. The pragram calls for eventual recavery af mice and mankeys in the capsule, which would be either air-snatched by planes ar picked up by ship. Discaverer is clasely tied ta the Samos and Midas pragrams.

MIDAS (Air Force)

TYPE: Early-warning satellite

STATUS: R&D

PRIME CONTRACTOR: Lackheed Aircraft Corp.

PERFORMANCE: *Orbit*—abaut 300 n. miles; palar.

DEPLOYMENT: *Initially operational*—abaut 1963. *Number satellites*—mare than a half-dazen.

FRAME: *System contractor*—Lockheed. *Height*—22 ft. *Diameter*—5 ft. *Weight*—about 5000 lbs. (aperational weight abaut 3000 lbs.)

INSTRUMENTATION: Type—IR scanner designed to detect exhaust flames of a lang-range ballistic missile secands after it is launched; data link telemetry; tape-fed pragramer.

BOOSTER: *System contractor*—Canvair. *Type*—Atlas ICBM. *Propellant*—liquid.

SUSTAINER: *System contractor*—Lackheed. *Type*—Agena. *Propellant*—liquid.

REMARKS: Midas II launched May 24, 1960, inta 300/319 mile orbit, but an equipment failure made testing af the IR scanner impassible.

SAMOS (Air Force)

TYPE: Recannaissance satellite

STATUS: R&D

PRIME CONTRACTOR: Lackheed Aircraft Corp.

PERFORMANCE: *Orbit*—Palar, several hundred miles.

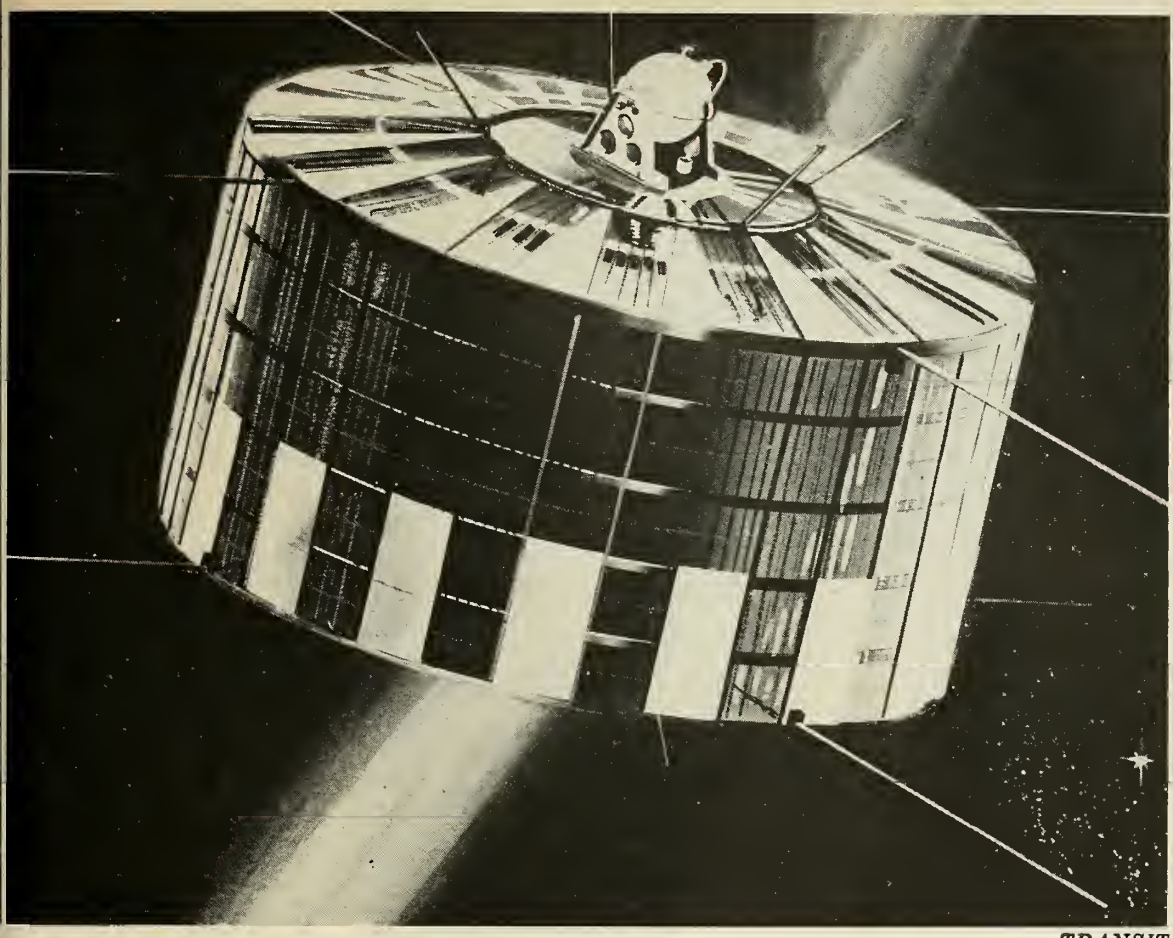
DEPLOYMENT: *Initially operational*—late 1962 ar early 1963. *Number of satellites*—less than 6.

INSTRUMENTATION: *System contractor*—Lackheed.

BOOSTER: *System cantractor*—Canvair. *Type*—Atlas. *Prapellant*—liquid.

SUSTAINER: *System contractor*—Lackheed. *Type*—Agena. *Propellant*—liquid.

REMARKS: Samas will provide a continuous recannaissance af the Earth.



TRANSIT

TRANSIT (Navy-ARPA)

TYPE: Novigotion sotellite.

STATUS: R&D

PRIME CONTRACTOR: Applied Physics Loborotory.

PERFORMANCE: *Orbit*—about 500 n. miles. (2 polor, 2 equotoriol.)

DEPLOYMENT: *Intiolly operotionol* mid or lote 1962. *Number of sotellites*—four.

FRAME: *System controctor*—APL. *Weight*—(Tronsit-1B) 265 lbs.; (Tronsit 11A) 223 lbs.; (Tronsit IVA) 175 lbs. (Operotionol weight obout 50 lbs.)

INSTRUMENTATION: *System controctor*—APL.

BOOSTER: *System Controctor*—Douglos. *Type*—Thor. *Propellont*—liquid.

SUSTAINER: *System controctor*—Aerojet. *Type*—Ablestor. *Propellont*—liquid.

POWER UNITS: Solor cell ond storoge botteries plus SNAP nucleor generotor.

REMARKS: Four R&D sotellites hove been put in orbit in six tries. All four hove operoted successfully. The lotest—IVA—wos lounched into o 557/620 mi. orbit June 29, 1961. It corried two piggybock sotellites—Injun ond GREB III—which seporoted ofter orbit injection. Tronsit will enoble surfoce ships ond submorines—porticulorly Poloris submorines—to fix their position by better thon o tenth of o mile.

AEROS (NASA)

TYPE: 24-hour meteorologicol sotellite

STATUS: R & D

PRIME CONTRACTOR: None oworded

MISSION: Stotionory equotoriol orbit, 22,300-mile oltitude

FRAME: Not determined

INSTRUMENTATION: TV comeros for cloud cover; wide oreo ond controllable voriable focus

BOOSTERS: Centour

POWER UNITS: Probobly solor cells ond botteries

REMARKS: Not officiolly opproved or funded. Fiscol 1962 fund request for development of voriable focus type lens ond preliminory system studies

TIROS (NASA)

TYPE: Meteorologicol sotellite

STATUS: R & D with experimentol operotionol use being mode of TV cloud picture doto

PRIME CONTRACTOR: Rodio Corporotion of Americo

MISSION: Photogrophs cloud cover ond tronsmits on ground commond

FRAME: *System Controctor*—RCA. *Diometer*—42 inches. *Height*—19 inches. *Weight*—270 lbs., Tiros I; 280 lbs., Tiros II; ond 285 lbs., Tiros A3

INSTRUMENTATION: *System Controctor*—RCA. Sconning ond nonsconning rodiotion sensors, norrow- ond wide-ongle comeros

BOOSTERS: Thor-Delto

POWER UNITS: *System controctor*—Hoffmon. Type—solor cells plus nickel-codmium storoge botteries

REMARKS: First lounching April, 1960. Second, Nov. 23, 1960. Both successful. Five more plonned

NIMBUS (NASA)

TYPE: Meteorologicol sotellite

STATUS: R & D

PRIME CONTRACTOR: NASA

MISSION: 600-mile retrogrode quosi-polor 80-degree orbit; eorth-stobilized using gos jets ond inertiol wheels (GE)

FRAME: *System Integrotion Controctor*—Generol Electric

INSTRUMENTATION: RCA vidicon comeros for cloud doto, rodiotion sensors ot vorious resolutions ond spectrol ronges for heot bolonce, temperoture ond cloud cover

BOOSTERS: Thor-Ageno B

POWER UNITS: Solor cells, poddles ond nickel codmium botteries (RCA)

REMARKS: First lounching scheduled for 1962



RELAY (NASA)

STATUS: R&D.

PRIME CONTRACTOR: Radio Corp. of Americo.

MISSION: Reloy wide-band communication signols by o less-thon-100-pound satellite. Study radiation effects on components.

FRAME: Not determined.

INSTRUMENTATION: Receiver transmitter, transistors, diodes, vacuum tubes, radiation experiment equipment.

BOOSTERS: Thor Delto.

POWER UNITS: Solor cells ond storage batteries.

REMARKS: First launching scheduled for 1962.

ECHO (NASA)

TYPE: Inflated balloon possive communicotions sotellite.

STATUS: R&D.

PRIME CONTRACTOR: NASA.

MISSION: Reflect radio signols off surfoce of 135-foot sphere.

FRAME: Mylar plastic ond aluminum foil lominote, G. T. Schjeldahl Co., ond Alcoa; contoiner by Grumman Aircraft Corp.

INSTRUMENTATION: Tracking beacons on sphere.

BOOSTERS: Thor-Ageno B.

POWER UNITS: Botteries ond solor cells.

REMARKS: To be lounched in 1962 in 700-mile circulor polar orbit.

REBOUND (NASA)

TYPE: Possive communications satellite using multiple launching of inflated spheres.

PRIME CONTRACTOR: None selected.

MISSION: Reflect rodio signol aff surfoce of sphere.

FRAME: Mylar plastic and aluminum foil laminate.

INSTRUMENTATION: None, trocking beocons on sphere.

BOOSTERS: Atlas Ageno B.

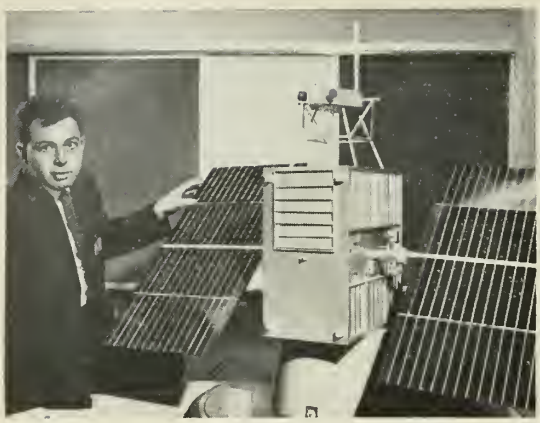
POWER UNITS: Batteries and solar cells.

REMARKS: First launching 1963. Atlos Ageno B vehicles to lounch three spherical satellites at on altitude of opproximotely 1700 miles.

ECHO I

SATELLITES IN ORBIT

Name and Country	Weight (lbs.)	Launch Vehicle	Launch Date	Est. Life	Current Apogee & Perigee (mi)	Purpose	Remarks
EXPLORER I, U.S.	30.8	JUPITER C	1/31/58	7–10 yrs.	1120 217	Radiotion measurement	Discovered Van Allen belt
VANGUARD I, U.S.	3.25	VANGUARD	3/17/58	200-1000 yrs.	2455; 404	Test VANGUARD concept	Solar battery-powered radio still operating
VANGUARD II, U.S.	20.7	VANGUARD	2/17/59	100-250 yrs.	2052; 343	Test weather-scan concept	
EXPLORER VI, U.S.	142	THOR-ABLE	8/ 7/59	Several months	26,357; 156 (at last report)	Radiation, space envrionment meosurements	First "paddlewheel', satellite; position uncertain.
VANGUARD III, U.S.	About 100	VANGUARD	9/18/59	50–150 yrs.	2318; 322	Radiation, space environment measurements	Ended VANGUARD program
EXPLORER VII, U.S.	91.5	JUNO II	10/13/59	30–40 yrs.	669; 344	Radiation, space environment measurements	Still transmitting some dato
TIROS I, U.S.	270	THOR-ABLE	4/ 1/60	50-100 yrs.	467; 429	Picture-taking weather satellite	Transmitted 22,952 cloud-cover photos in 78-day instrument lifetime
TRANSIT IB, U.S.	265	THOR-ABLESTAR	4/13/60	6 yrs.	417; 229	First R&D Navigational satellite	A8LESTAR achieved first known restart in space
SPUTNIK IV, Russia	10,008	N. A.	5/15/60	2–3 yrs.	322; 175	Test support systems, cabin for manned flight; attempted return from orbit	Original apogee 229, perigee 188; poor retro orientation spoiled return attempt
MIDAS II, U.S.	5,000	ATLAS-AGENA A	5/24/60	8–15 yrs.	315; 297	IR scanning for early warning of missile launchings	Telemetry failed 5/26/60. AGENA 8 restorted in space
TRANSIT II-A, U.S.	223	THOR-ABLESTAR	6/22/60	50–200	649; 389.1	Second R&D navigational satellite	Carried "piggyback" for first twin satellite launching. Transmitting.
GREB, U.S.	40	THOR-ABLESTAR	6/22/60	50–200 yrs.	657; 381	Radiation measurements	Passenger aboard TRANSIT II-A
ECHO I, U.S.	132	THOR-DELTA	8/20/60	2–16 yrs.	994; 934	Communications; put 100 ft. inflatable sphere in orbit	First successful orbiting of passive communications satellite
COURIER IB, U.S.	500	THOR-A8LESTAR	10/ 4/60	200–500 yrs.	750; 604	Communications; test feasibility of delay repeater for military	First successful launch of delayed active repeater satellite
EXPLORER VIII, U.S.	90	JUNO II	11/ 3/60	20–50 yrs.	1412; 262	Ionosphere investigation	No longer transmitting
TIROS II, U.S.	280	DELTA	11/23/60	200–500 yrs.	461; 378	Test leading to world-wide meteorological information system	Still transmitting usable data
SAMOS II, U.S.	4100	ATLAS-AGENA	1/31/61		342; 295	Reconnaissance satellite	First R&D model
EXPLORER IX, U.S.	15	SCOUT	2/16/61		1580; 430	Evaluotion of SCOUT vehicle and study of atmosphere	12-ft, "polka dot" balloon
DISCOVERER XX, U.S.	2450	THOR-AGENA	2/17/61		444; 176	Evaluation of AGENA B satellite	Orbit ochieved. No recovery attempted
DISCOVERER XXI, U.S.	2100	THOR-AGENA	2/18/61		572; 154	IR meosurement equipment for MIDAS progrom	Agena restorted in spoce for first time
EXPLORER X, U.S.	78	THOR-DELTA	3/25/61		Uncertain	Data on mognetic fields and effect by ond on solar plosmo	Transmitted data for 60 hrs.
DISCOVERER XXIII, U.S.	2100	THOR-AGENA	4/ 8/61		372; 183	Evaluation of AGENA B satellite	Capsule ejected in wrong direction, sending it farther into spoce
EXPLORER XI, U.S.	82	JUNO II	4/27/61		1107; 302	Measure gammo rays from the stars obsorbed in earth's atmosphere	Vehicle and poyload functioned as plonned
DISCOVERER XXV, U.S.	2100	THOR-AGENA	6/16/61		250; 139	Systems evoluotion of AGENA B	Orbit ochieved, copsule recovered.



ADVENT

ADVENT (Army)

TYPE: 24-hour communicotions satellite

STATUS: R&D

CONTRACTORS: Army Signol Corps., *Prime*—Bendix, prime for 24-haur satellite communications package; GE, vehicle.

MISSION: Place 1250-lb. communicotions satellite into orbit.

BOOSTERS: Atlos-Centaur, also may use Titan II.

REMARKS: First launching scheduled for late 1962.

COURIER (Army-ARPA)

TYPE: Delayed-repeater communication satellite

STATUS: Operatianal 1960

PRIME CONTRACTOR: Army Signal Research and Development Laborotories.

PERFORMANCE: *Orbit*—about 650 n. miles. *Operatianal life*—about 1 yeor.

FRAME: *System cantractar*—Philco Corp. *Diameter*—about 50 in. *Launch weight*—about 475 lbs.

INSTRUMENTATION: *System contractar*—Philco. *Type*—microwove receivers, VHF transmitters.

BOOSTER: System cantractar—Douglos. Type—Thor.

SUSTAINER: *System* cantractar—Aerojet. Type—Ablestar.

POWER UNITS: Type—solar cells (obout 20,000); nickel-codmium botteries.



ECHO

OSO (NASA)

TYPE: Orbiting Solar-Observatory.

PRIME CONTRACTOR: Ball Brothers:

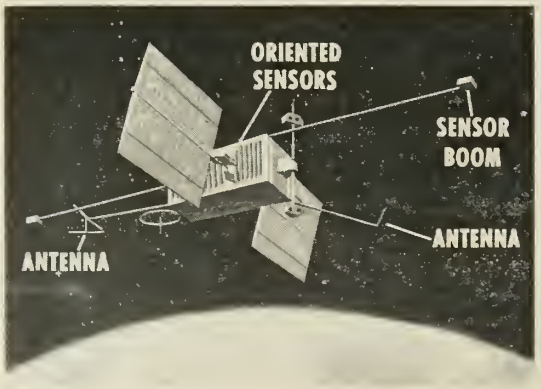
MISSION: Place 350-lb. satellite into orbit for observation of solar radiation.

INSTRUMENTATION: Spectrographs, X-rays, gamma rays.

BOOSTERS: Thor Delta.

POWER UNITS: Solar cells recharging cadmium batteries—78 watts.

REMARKS: First launching scheduled for third quarter 1961.



OGO

OAO (NASA)

TYPE: Orbiting Astranamical Observatory.

STATUS: R&D.

PRIME CONTRACTOR: Grumman (prime), Westinghause (electric companents), Generol Electric (stabilizatian and controls).

MISSION: Place 3500-lb. satellite equipped with telescope inta orbit.

FRAME: Eight-sided satellite, 9½ ft. high and 6½ ft. in diameter.

INSTRUMENTATION: Will contain 1000 lbs. of experimental equipment, including television tube, telemeter equipment, 24 in. mirror and spectrameter.

BOOSTERS: Atlas Agena B.

POWER UNITS: Solar cells to provide 350 watts.

REMARKS: First flight expected in late 1963 or 1964.

OGO (NASA

TYPE: Orbiting Geophysical Measurement Observatory.

STATUS: R&D.

PRIME CONTRACTOR: Space Technalogy Laboratories.

MISSION: Place 1000-lb. satellite into orbit with instruments for geaphysical measurements. Polar and eccentric shots planned.

FRAME: Satellite will be 6 ft. long by 3 ft. in diameter.

INSTRUMENTATION: Capable af carrying instruments for 50 different geophysicol experiments on any ane mission.

BOOSTERS: Atlos Ageno B, Thor-Agena B, Centaur.

POWER UNITS: Solar cells ond staroge batteries with 50 watts available far experiments.

REMARKS: First launching expected in 1963.

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Parts molded of J-M Thermomat® meet the extreme service demands of the missile age

Here is a unique new molding compound in sheet form that offers many advantages in rocket and missile applications. Cured parts and components molded of J-M Thermomat—such as the collar you see here—have already proved they can meet the most extreme service demands.

Because these parts withstand high temperatures, offer maximum resistance to ablation and erosion... they are currently being used as an erosive flame shield for protecting critical guidance and stabilizing mechanisms on operational missiles.

Thermomat's high strength-to-weight ratio is another important advantage, permitting rocket weight to be reduced and fuel capacity increased. Thermomat parts also have a high modulus of elasticity.

In sheet form, this non-woven asbestos-phenolic molding compound is unusually conformable and pliable, making assembly quicker and easier. Molders like the way joints and seams work together as readily as putty . . . and the fact that one man can handle lay-up, saving hours of time.

Non-fillouts are at an absolute minimum, even on complex configurations. Asbestos fibers are free-flowing during molding, resulting in a uniformly reinforced part. This versatile product lends itself to both low and high press molding cycles, thus keeping inventory and waste to a minimum. Any machining of cured Thermomat parts to precision tolerances can be easily accomplished with standard metal-working equipment.

Thermomat is supplied in sheets 14" wide . . . approximately 12' long ...and 3/16" thick. Thermomat in other dimensions may be supplied on request. Molders are invited to write for Technical Bulletin TX-10A and a generous free sample in order to try this remarkable molding material for themselves. Write Johns-Manville, Box 14, New York 16, N.Y. In Canada: Port Credit, Ont.

JOHNS-MANVILLE
THERMOMAT

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dead center

Kelsey-Hayes thrust vectoring systems give missiles proper directional control.

Kelsey-Hayes is contributing substantially to the design, development and production of new thrust vector control systems for solid fuel propulsion.

For example Kelsey-Hayes, in a recent crash program, designed and fabricated a movable nozzle control that passed static firing tests for one of the newest sophisticated missile systems.

The swivel nozzle control is just one of the latest developments by Kelsey-Hayes as a subcontractor of propulsion subsystems, flight componentry and high performance materials. Spearheading Kelsey-Hayes activities is the Advanced Design Group, a flexible team of experienced design specialists.
Kelsey-Hayes Company,
Detroit 32, Michigan.

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OPERATIONAL PLANTS: Detroit, Jackson and Romulus, Michigan; Los Angeles, California; Philadelphia, Pennsylvania; Springfield, Ohio; Utica, New York; Davenport, Iowa; Rockford, Illinois; Windsor and Woodstock, Ontario, Canada.

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Technical Countdown

ELECTRONICS

ESG Research Nears Fruition

Minneapolis-Honeywell's electrostatic gyro development effort is snowballing. Funding to date is reportedly well over $8 million. The project was begun in 1956 under a Navy contract; it was later decided to employ the gyro in an advanced *Polaris* IRBM guidance system. The Air Force is now partially funding the program. Since January, 1961, test units have accumulated over 6000 hours operating time. One Honeywell ESG has been operated continuously for over 2000 hours.

Saturn Guidance Selected

Marshall Space Flight Center has selected the *Centaur* guidance platform, with modifications, for use in early *Saturn* flight vehicles. (TECHNICAL COUNTDOWN reported last week that Librascope had been chosen to provide the guidance computer.) The modified *Centaur* inertial system and test equipment will be developed by Minneapolis-Honeywell under a $1.134-million contract. (Note: Five *Centaur* guidance systems have been delivered to date to Convair by Honeywell.)

Miniaturizing by Necessity

Computer experts have reached an impasse, according to one National Bureau of Standards scientist, which can be resolved only by miniaturizing future computers. The main limitation in faster response time, it seems, is the distance between computer elements. Miniaturization can reduce this transit time. Also being discussed is use of the transistor's active element for transmission paths—to reduce even further the time required for information to get from one place to another.

Control Data for Space Vehicles Determined

A study done for the Air Force by Bell Aerosystems Co. has determined that the data most essential for the control of high-altitude and space vehicles were primarily velocity, attitude, density altitude—and the rates of change of these quantities, when available.

Synthetic Eye Conceived for Guidance

Based on a long-term study of the human visual system, General Electric's Advanced Electronics Center in Ithaca has conceived a bionics machine for potential use in spacecraft terminal guidance. Called Visilog, the design calls for a synthetic eye capable of perceiving two-dimensionally, measuring and processing information. Such a system, says G.E., would be capable of both performing slant estimation (for depth) and obtaining an impression of closing distances.

New Memory Device Introduced

A new thin-wall cylindrical film memory device with outputs for "one" and "zero" range to several hundred millivolts has been produced by CBS Laboratories. Film thicknesses of 30,000 Angstroms have been achieved for rotational switching, as compared with thicknesses of 1000-4000 Angstroms obtained with planar dots.

Vertical Sensing Element Revealed

A gravity-sensitive, liquid-damped pendulum—capable of electromagnetic vertical sensing—has been introduced by Kearfott. A jewel-suspended permeable mass acts as the variable reluctance for two orthogonally-mounted differential transformers in order to provide a phase-sensitive output signal proportional to the tilt angle.

OPTICS

Optics in Space to be Studied

What happens to optical instrumentation in space will be studied in an 18-month contract newly awarded by the Air Force to ITEK Laboratories. Principal goal in the million-dollar task is to develop criteria for future development of optical systems to assure their survival in the space environment without undue degradation. Study will look at all factors including temperature change, launching shock, vibration, and high-energy radiation. ITEK approach will be to test a typical high-performance optical system in simulated environments in its laboratories.

ASW & SEABORNE SYSTEMS

Celestial Navigation Proposed for Subs

A modified aircraft celestial star tracker mounted on top of a submarine periscope can substantially improve the ship's navigation capabilities, a Kollsman Industries spokesman feels. A semiautomatic, photoelectric sextant—basically a modified version of a system used on the B-57—would automatically track a star or other celestial body for position fixing. The system would also compensate for both hull rocking and periscope bending.

Surface SINS Serves Successfully

The N7C marine inertial navigation system built for the Air Force by Autonetics has been operated successfully for over 3000 hours without failure, the NAA division says. Used aboard the USS Twin Falls Victory, new tracking vessel on the Atlantic Missile Range, the system is similar to the SINS system used to guide *Polaris*-carrying submarines.

New Sub Steering Tested

Submarine piloting may soon be as simple as steering a car down a super-highway. Aboard the nuclear attack submarine Shark, the Navy has been conducting experimental tests—so far successful—of a system known as CONALOG, for "contact analog." The new system displays on a screen tube a "highway" with a "floor" and a "ceiling" which simulate the proper course and the bottom and surface of the ocean. Changes in course put the submarine "on" or "off" the road. Inputs are desired course, speed and depth into a display generator.

SUPPORT EQUIPMENT

Will Computers Replace Managers?

PERT's current extension into cost and reliability is being watched with high interest in the Defense Department and may be harbinger of PERTing entire weapons and space systems (see p. 110). Ultimate PERT is being seen as one in which resources and weapons systems objectives are cranked into a computer which in turn puts out the proper mix of money, time utilization and system performance.

PERT's Horizon Beginning to Widen

Proven in Polaris program, concept which now includes cost measurement may be used on full weapon/space

by William Beller

THE NAVY'S computerized management tool—PERT (Program Evaluation and Review Technique)—is being extended to measure systems cost and reliability.

The Defense Department, moreover, is reported considering expanding the scope of PERT to the analysis of entire weapons and space systems.

Backing for PERT-type analysis—the method used so effectively to help telescope the *Polaris* R&D timetable and which the Army and Air Force have started to use in major systems development—is already apparent in high places.

Charles J. Hitch, former RAND economist, is known to favor a better accounting of weapons systems costs, from concept to deployment. In his book, "Economics of Defense in the Nuclear Age," which has become quite popular since his appointment as Defense Department comptroller, he says:

"Efficient techniques and policies have to be selected consciously; and wherever the relevant factors are diverse and complex as they frequently are, unaided intuition is incapable of weighing them and making an efficient decision."

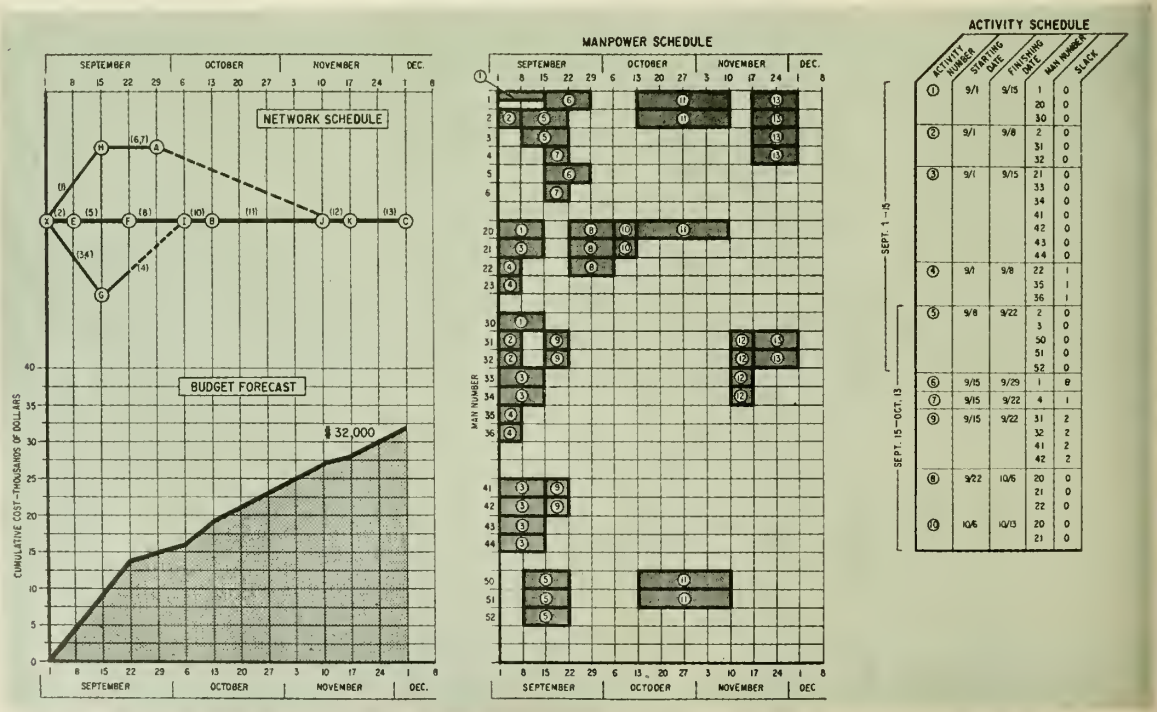
• **Time is the measure**—The original PERT as it emerged out of the Navy's Special Projects Office was developed by an industry-military team to get complex jobs done on schedule. "Time" was used as the independent variable and PERT gave managers the equation by which they could plan, schedule and control the effects on time of R&D procedures and industrial performance. This use is now known as "PERT-TIME."

Then early this year, the Special Projects Office set up an operations research team to inject "cost" into PERT. The intent is to plan, measure and control dollar costs and physical resources through PERT logic. The work has already advanced to data collection for a feasibility test on a *Polaris* component.

The Office is also developing another major offshoot of PERT-TIME for monitoring, predicting and controlling weapon and space system reliability. Code-named PRISM—Program Reliability Information System for Management—the new concept is already being pilot-tested, in part, by monitoring contractor and customer compliance with reliability requirements during development of the A-3 *Polaris* system.

• **Return on principal**—Many management dividends are seen accruing to organizations investing even a small amount of time and effort in PERTing costs. Among these are:

(Continued on page 113)



PERT-COST OUTPUTS include continuous budget forecasts and manpower loadings.



HERE AT ELGIN...

We've been waiting . . . for this new age of space and rocketry to come along, for its unique requirements to develop . . . waiting *and preparing*. Actually, the hand-in-glove application of our experience and capabilities in this connection became apparent more than 15 years ago.

At that time, we organized our first industrial division, today known as the **ABRASIVES** Division, working with unusual materials and alloys and processing diamond abrasive compounds of superior quality. Next came our ordnance operation, organized to develop and produce miniature and subminiature mechanisms of all kinds, especially for governmental agencies. It has now expanded into our **MICRONICS MIDWEST** and **MICRONICS WEST** Divisions.

This pattern of preparation led inevitably into the field of electronics, and our **ELECTRONICS** Division was producing miniaturized circuit components as early as 1955. Some of these early achievements are still recognized as standards for performance and reliability.

Most recently, our involvement in a wide variety of projects in their developmental stages has resulted in the organization of our new **RESEARCH AND ENGINEERING** Division. And so, as the new technologies of the space age come to maturity, we're organized, experienced and equipped . . . *ideally situated to offer economically practical proposals to meet the sophisticated requirements of advanced defense, space exploration and communications systems.*

Our study group, thoroughly experienced and familiar with space age concepts of reliability and precision, is at your service . . . phone or write.

ELGIN INDUSTRIAL GROUP

MICRONICS MIDWEST | MICRONICS WEST | ABRASIVES
ELECTRONICS | RESEARCH AND ENGINEERING

Divisions of ELGIN NATIONAL WATCH COMPANY, Elgin, Illinois

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Possible RecordTemp Range Set in Solid Tests

Grand Central's new solid undamaged after tests from —120 to 220°F—big-booster evaluation firing imminent

A SIGNIFICANT STEP toward production of space rocket motors has been achieved by Grand Central Rocket Co., following tests of a new solid propellant over what is believed to be the widest temperature range ever achieved.

More than thirty test-firings without failure have been made on a nominal 4000-lb.-thrust test motor from —100 to 180°F at Grand Central's Beaumont Proving Grounds. The GCR-developed solid propellant also passed the more severe temperature-cycling test from —120 to 220°F without damage to the case liner or the grain, said Albert T. Camp, Assistant Vice President and Chief Staff Scientist.

The GCR-supported program for the development and selection of a solid propellant for the big boosters, Camp explained, required a full evaluation of the factors of propellant performance, ignition characteristics, physical properties, processibility, cost and availability of ingredients, resistance to deterioration upon aging, safety from detonation and combustion stability.

Before a specific propellant composition was chosen, the company conducted one of the most thorough analytical and experimental studies ever undertaken to determine the exact propellant properties required for the Air Force big-booster motor design. The new propellant was then tailored to fully meet all these requirements. A GCR production igniter was used for each test with no hangfire or other evidence of low-temperature problems.

The new propellant is known as Polycarbutene-R, Camp said. It is made from a production-type liquid polymer of butadiene and acrylic acid, which has been available in large volumes for less than 3½ years. Aluminum powder is added to the mixture at a typical percentage, exact numbers being retained as proprietory information.

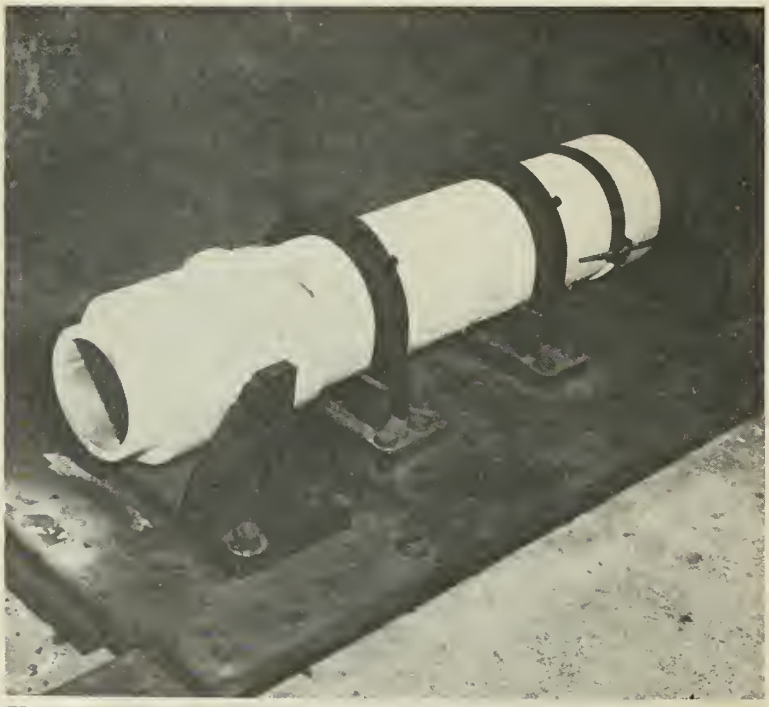
Grand Central attributes its success in developing the space propellant to use of advanced types of curing agents, available only in the past year to solid-propellant processors. When the polymer is combined with the new curing agent (of which even the name is still classified), the curing process can be accomplished faster and at lower-than-normal temperatures, explained Camp. He describes modern curing agents as the "handles" for the curing reactions.

The development of the liner used to bond the cast propellant charge to the motor case was equally important, and as difficult a task as the propellant work. "Here the problem is to develop a material that is highly cohesive and extremely adhesive to propellant and hard surfaces alike," Camp noted. The properties of the liner material are slightly different from those of the grain. GCR chemists found that a polymer of butadiene acrylonitrile and acrylic acid made it possible to qualify the liner system in laboratory and firing tests from —110 to 220°F.

Grand Central Rocket plans to test-fire two subscale, three-foot-diameter segmented motors this summer containing more than 5000 lbs. of the new propellant each to determine how the compound will perform in the multi-ton units planned for the nation's big-booster program.

The tests will be supplemented by the test-firing of two larger motors, also at the Beaumont facility, containing approximately 8000 lbs. of the Polycarbutene-R. The test-firings will be conducted on units conditioned over a wide range of temperatures.

"This is the propellant," said Camp, "which Grand Central Rocket is proposing for the big rockets to be developed for the lunar landing and space probe programs because it provides superb physical properties over a wide range of temperatures under all conditions of service." ⁂



FRIGID MOTOR—Fifty-lb. motor shown here is heavily coated with frost from its —50°F temperature as it is ready for test-firing at Grand Central.

(Continued from page 110)

—The ability to see the effects on costs of different mixes of tasks, times and specifications.

—A basis for finding the set of resources that will use a task's R&D dollars and time available to best advantage.

—A means for anticipating and assessing trouble spots.

—A technique for showing alternate paths that can be taken and their costs.

—A method for improving corporate control of costs and time.

—Perhaps most valuable of all, a way to give management relevant cost information quickly, accurately and on an exception basis.

It may be remembered that the PERT-TIME analysis of an R&D task gives to management in a highly readable form—the PERT network—a constantly current report on (1) the bottlenecks that can be expected, that is, the "critical paths"; and (2) the associated activities that can be done with time to spare, that is, the "slack paths." From these data, management can anticipate scheduling problems and make appropriate decisions.

Thus PERT-TIME suffices for a crash R&D program where money and assured reliability are subordinate to time.

But for the more familiar types of R&D tasks, where costs and reliability play parts equally as important as schedules, the outputs from a PERT-COST analysis are needed. These can include:

—Expected project direct costs by skill, month and department.

—Expected manpower requirements by skill, month and department.

—Individual man loading by month.

RELIABILITY MATURITY INDEX (RMI)

INERTIAL GUIDANCE SYSTEM

As of Date _____

ITEM (COMPONENT AND SUBCOMPONENT)	COMPLIANCE RATING FACTORS	RELIABILITY ACTIVITIES: DESIGN SPECIFICATION	ENGINEERING TEST SPECIFICATION	ENVIRONMENTAL TEST PLAN	FLIGHT TEST PLAN	RELIABILITY TEST SPECIFICATIONS	QUALITY INSPECTION TEST REPORT	RELIABILITY EVALUATION	REPAIR AND MAINTENANCE MANUAL	RELIABILITY TEST EVALUATION		COMPOSITE: ACTUAL	PLAN
GIMBAL PLATFORM	SCHEDULE												
	QUALITY			DANGER	DANGER							DANGER	
GIMBAL HEAT EXCHANGE	SCHEDULE												
	QUALITY		DANGER									DANGER	
ELECTRONICS PACKAGE	SCHEDULE												
	QUALITY												
GIMBAL PLATFORM ELECTRONICS	SCHEDULE				DANGER							DANGER	
	QUALITY												
INERTIAL GUIDANCE SYSTEM	SCHEDULE					DANGER						DANGER	
	QUALITY	DANGER			DANGER							DANGER	

RELIABILITY DANGER SPOTS anticipated by PRISM.

• **Cost easily considered**—The PERT-COST analysis is a follow-on to PERT-TIME. The data for each is obtained by interviewing responsible working-level people engaged in each of the



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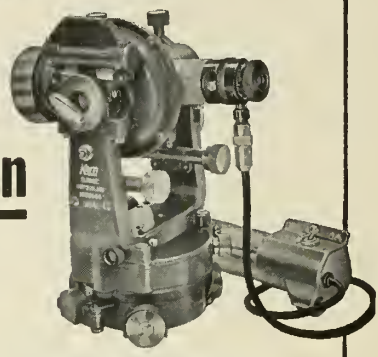
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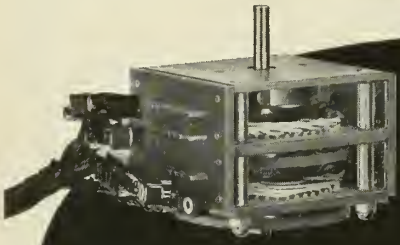
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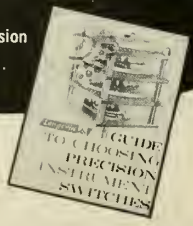
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activities that make up the project. For example, if information is needed on the time to fabricate a wing section, the production foreman in that area might be the man to talk to; and he also might be able to give cost data for PERT-COST.

Such costs are then aggregated on a network-activity basis, unlike the usual accounting procedure where costs are aggregated on a functional basis. Thus an accountant will often say that so many dollars are being spent for fabrication, for electronics, for propulsion and so forth; but he will have no easy way to fit these jigsawed cost pieces into a complete picture until the money is gone.

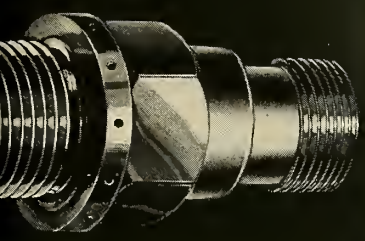
On the other hand, if costs are assigned to network activities, then the accountant still has his data for conventional financial reports; and just as important, he now has data with which all levels of management can anticipate their particular budget problems in time to do something about them. In addition, management will be able to see the choices that are open to them and the cost of each of these in terms of time and dollars.

The man who Vice Admiral William Raborn describes as "the father of PERT," Willard Fazar of the Special Projects Office, foresees PERT-COST becoming an important government and industry management tool for making time-cost tradeoffs; improving cost estimates and resource allocations; anticipating over-runs and under-runs; and justifying changes in costs, times and technical plans.

A major move toward fulfilling Fazar's prophesy is being taken. Earlier this year Hitch ordered the FY 1963 defense budget be placed on a program and project basis with ready cross-reference into the regular budget classifications. This directive is causing more than a little furor among Pentagon financial people, who now must realign their thinking as well as their data.

The team set up by the Special Projects Office to design, develop and test PERT-COST includes Dr. J. Sterling Livingston, of the Harvard Graduate School of Business Administration and of Management Control Systems, Inc., as contract supervisor; D. G. Malcolm, of Operations Research, Inc., a supervisor of the original PERT operations-research team; and Fazar as task monitor.

• **Reliability the next job**—The task of devising a technique that PERT-like will anticipate reliability problems before they arise, and perhaps even predict the reliability of a weapon system before it is built, was given to Operations Research a little over a year ago. PRISM emerged from the company's



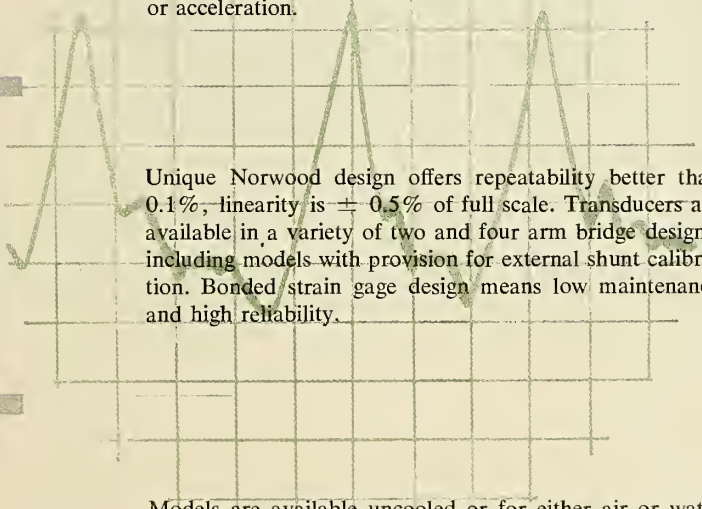
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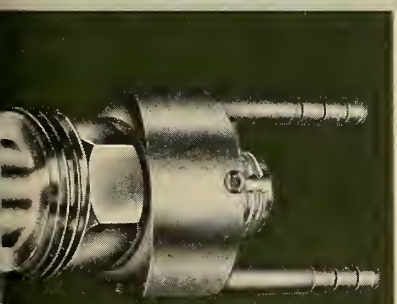


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research, a method composed of the following two systems:

1) *Reliability Maturity Index (RMI).* A method for monitoring customer and contractor compliance with reliability requirements.

2) *Reliability Performance Measure (RPM).* A method for estimating system, sub-system and component reliability.

The Reliability Maturity Index does two things: it tells how much of the reliability program has been completed, and how well. For these purposes, reliability events and activities are put into the PERT-TIME network. Thus, reliability is monitored the same way a piece of hardware is.

Reliability activities are interpreted broadly to include any action that has a bearing on the quality of a weapon system's performance. The activity does not have to be designed specifically to test reliability and would include items such as writing specifications, running laboratory and field tests and training operating personnel.

Lockheed Missiles and Space Co. is using RMI on the *Polaris* program. Because each reliability event is PERTed, and consequently its status continuously known, a summary sheet can be derived which shows how well reliability is "maturing." Called a *Schedule Compliance Evaluation (SCE),* it shows periodically the planned schedule of all reliability activities as well as when they are started and completed.

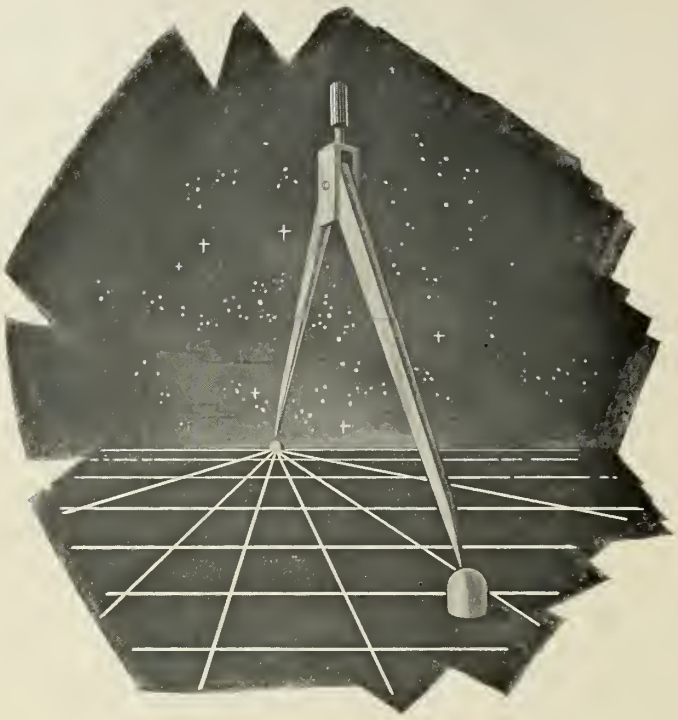
For each completed activity, a *Technical Qualitative Evaluation (TQE)* is made by a responsible reliability group. This group indicates on a percent basis its general degree of satisfaction with the quality of the completed activity.

Here is an example of the use of TQE. Often there'll be a missile flight test, and at the time the contractor may say. "Oh, yes, we've met our schedule." The test may have been a complete flop or a partial success, but it didn't do the job that was planned for it on schedule. TQE attempts to relate the degree of success of the mission with the schedule. Where there is excess disparity, a "danger" signal is flashed on the RMI summary sheet.

The Reliability Performance Measure—a means for predicting a weapons system reliability throughout its life cycle—is still being developed. The Special Projects Office hopes to have a system ready for pilot-testing before the end of the year.

What is wanted in the ultimate PERT system is a computer method in which the factors of time, cost and technical performance are inter-related.

(For another look at PERT, see the July issue of ARMED FORCES MANAGEMENT *an American Aviation Publication.)* ■



WHAT TIME IS IT 20 MILES AWAY?

A few years ago, the answer to this question would have been unimportant. Today, however, when time measurement is used to support missile and space flights, it has been necessary to introduce a superior method of time and frequency synchronization to meet special needs.

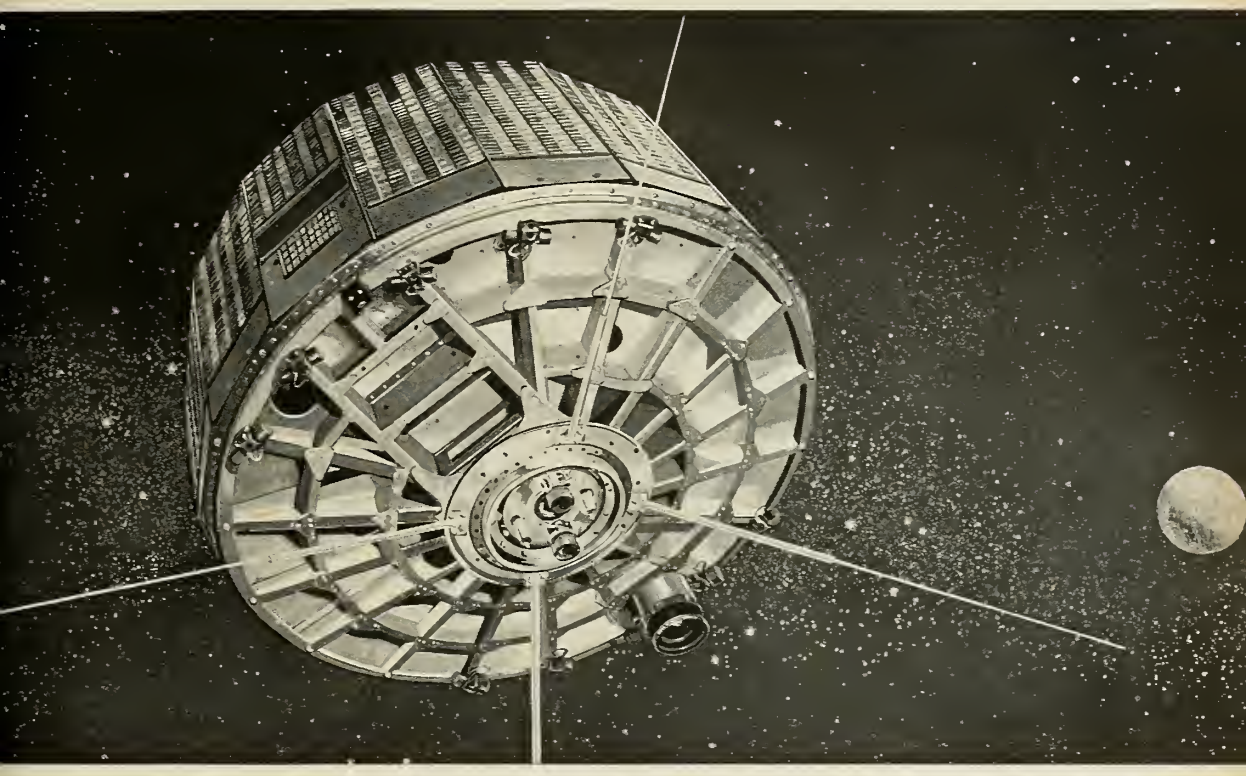
Prior to the use of radio transmissions, time measurements were made from astronomical observations and correlated by mechanical chronometers. Radio signals were transmitted in the high frequency spectrum, but accuracy was limited due to interference and the transmission medium itself. Just a short time ago even the best techniques of time and frequency synchronization yielded accuracies of no better than one part in 10^7.

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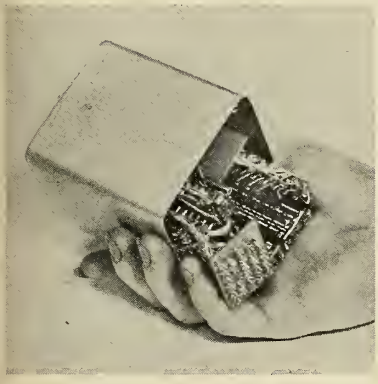
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Army-Made Fuzing Device Weighs 14 oz.

A DIGITAL programer-timer — one-fifth the size of any arming and fuzing device now in use—has been developed and flight-tested in five *Little John* test vehicles by the Diamond Ordnance Fuze Laboratories.

Containing no moving parts, the 14-oz. programer, a component for the Army's *Missile A* weapon system, is only one of many electronic devices that DOFL's Copperhead fuze system is expected to yield.

• **Copperhead program** — Several years ago the Army Ordnance Corps made a study of the state-of-the-art of the components being used in the design of its tactical weapon systems. As a result of this investigation, the Army discovered that missile designers were using components that lagged behind the electronic art by approximately five



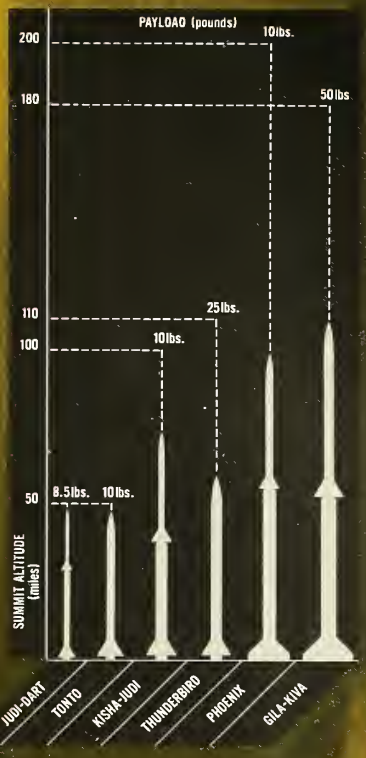
SMALL ENOUGH to be held in the palm of one hand, the DOFL-developed programer-timer promises to replace the old-fashioned electro-mechanical devices used in warhead fuzing systems. The programer weighs only 14 ounces and has a total volume of 10 cubic inches.

years. This situation is attributed to the reluctance of the design engineer to use an untried component in a new missile system.

The Ordnance Corps, therefore, assigned to each of its arsenals an area of component development responsibility consistent with its past experience. DOFL was given cognizance over electronic fuzing and, from this mission, the Copperhead program has grown.

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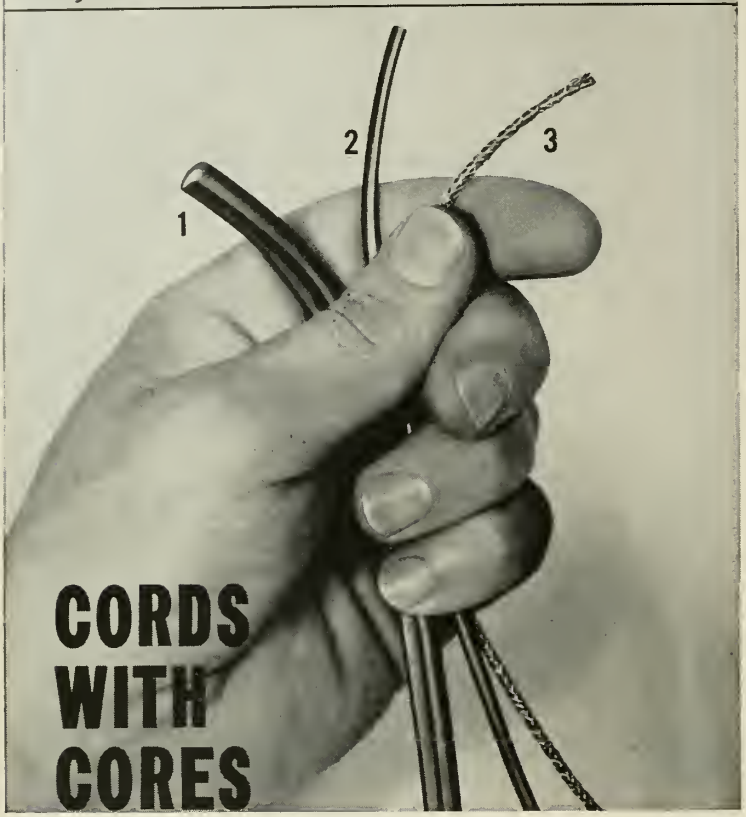
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The primary goal of this program is to provide the missile design engineer with a versatile, state-of-the-art component for new systems and, also, to anticipate and develop components for future missiles. The programer-timer is one of the highly integrated devices that are expected to radically change future warhead arming and fuzing techniques.

• **Functioning**—During the missile flight, the programer-timer—essentially a digital electronic clock—follows a preset program fed into it prior to launch.

Transistor output switches, capable of handling 2.0-ampere loads, are triggered to allow various warhead functions to occur. One of these outputs provides a 0.1-sec. signal at any desired place along the trajectory, five other outputs occur in a fixed sequence (8.0, 4.0, 3.9, 3.2 and 1.6 seconds in this application), and the final output represents the firing signal.

• **Advantages** — Past fuzing and arming devices have been electromechanical in nature. However, they have required large amounts of space and power, whereas the DOFL programer has a total size of 10 cu. in. and the timer requires only 0.1 ampere at 6.7 volts to operate.

Since the programer has no relays or mechanical elements, it is insensitive to the combination of spin and longitudinal forces created by small, spin-launched missiles. DOFL engineers feel that electro-mechanical clocks couldn't function under this combination of forces.

Finally, the digital programer-timer has an accuracy of one part in 10,000, the capability of one-tenth of a second settings, and the tactical advantage of allowing the unit commander to change



SWITCHING SECTION (top) and clock and timer sections (bottom) are heart of the new programer-timer. The unit was constructed and packaged by the Electronics Division of Cleveland Metal Specialties Company, using photo-engraved circuit techniques.

the timing sequence right up to launch using a high-speed pre-set counter.

• **System description**—The programer consists of two units: a small, transistorized ground control unit and the missile-borne programer-timer.

The ground unit—a counter which is preset to the flight, or fuze, time desired—sends pulses at a 7kc. rate to a group of 11 binary counters in the programer. Each pulse reduces the maximum fuze setting by .1 seconds until the value set on the ground control unit has been reached. The time required for this operation is approximately one-sixth of a second.

The programer-timer consists of an integrator, accelerometer, timer, output amplifier and a switching array. At the heart of the system is a quartz crystal oscillator which vibrates at a frequency of 20.48 kc. and has an accuracy of one part in 1,000,000 over a temperature range of 65-165°F.

• **Binary counter array**—The pulse signal from the oscillator is fed into the first bank of 11 binary counters which have an output of 10 cps. The 10-cycle signal is then fed to a second bank of 11 binary counters, where it is stored for the timing sequence. The total time available is, therefore, 204.8 seconds. However, for the particular application of this timer, the total usable time has been reduced to 113.6 secs.

A group of 14 NOR circuits is used to read out the second group of binary counters at pre-selected times. The first four readout times are shut off after 0.1 sec.—the basic programer time interval, the fifth remains on for several seconds, and the sixth is the firing signal. All readouts would correspond to various arming and fuzing functions within the warhead adaption kit.

To preclude unintended or accidental arming, the accelerometer in the programer must sense a load of 20 gs for at least 400 feet before any of the arming sequence takes place.

• **Present applications**—In addition to performing as a warhead programing and arming device, the programer-timer has a number of other applications. Foremost among these are manufacturing process control, aircraft collision control, and programed satellite functions. According to one DOFL engineer, the device could be used to time-program almost anything—"even a washing machine if you wanted to spend that much money."

DOFL is already at work on a 50-hr. clock which will contain its own power supply. Also, as part of the Copperhead component development program, they are studying ways of even further improving the programer and other elements of the up-to-date electronic fuzing system that they are developing. ⌗

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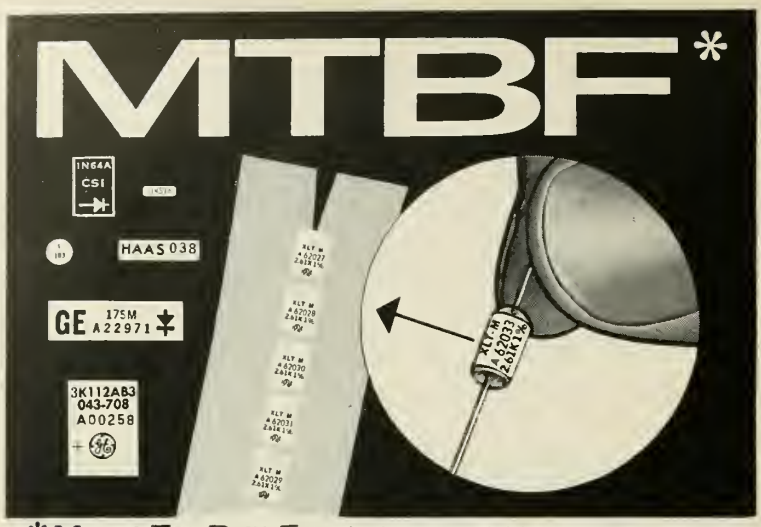
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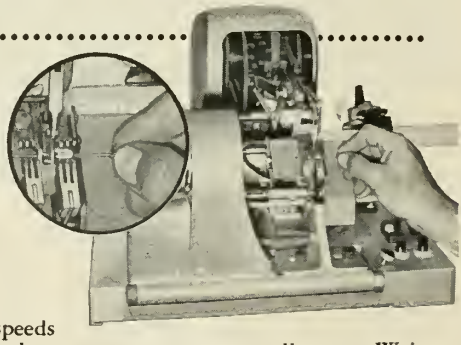
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$998,753—**Minneapolis - Honeywell Regulator Co., Aeronautical Div.**, St. Petersburg, Fla., for furnishing necessary engineering and manufacturing services to adapt the *Centaur* guidance set to meet *Saturn* requirements; $135,502 for fabrication, test and delivery of three gyros, accelerometers, test stations and field support services for *Saturn*.

$490,000—**Chrysler Corp.'s Missile Div.**, Huntsville, Ala., for qualification and reliability testing of *Saturn* ground support equipment subsystems and components.

$450,000—**Douglas Aircraft Co.**, Santa Monica, Calif., for developing orbital placement techniques and engineering design specifications for the Project *Rebound* spacecraft.

$193,729—**Eclipse-Pioneer Div., Bendix Corp.**, Teterboro, N.J., for six integrating gyros and six stabilizing gyros for *Saturn*.

$136,000—**General Electric Ordnance Dept.**, Pittsfield, Mass., for development work on a cryogenic gyroscope.

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$49,910—**Space Technology Laboratories, Inc.**, Los Angeles, for investigation of merits of assembling *Saturn* boosters in both horizontal and vertical positions.

ARMY

$2,999,986—**Northrop Corp., Nortronics Div.**, Hawthorne, Calif., for arming devices for *Sergeant* missiles; $3,957,124 for 112 launchers for *XM-78E3* missile.

$1,300,000—**General Electric Co.**, Burlington, Vt., for production of safing, arming and fuzing adaption kits for *Little John* rocket.

$423,619—**Western Electric Co.**, Laureldale, Pa., for production engineering measure for 1000 MC germanium transistor.

$258,000—**University of Michigan**, Ann Arbor, for research services to conduct investigation of a physical model for satellite detection.

$238,767—**CTS Corp.**, Elkhart, Ind., for subminiature, transistor-type potentiometers.

$188,145—**Landers, Frary & Clark**, New Britain, Conn., for IM-108 radiacmeter.

$172,257—**Stevens Institute of Technology**, Hoboken, N.J., for research investigation of plasma acceleration.

$170,000—**Weinschel Engineering**, Kensington, Md., for development and production of prototype of a microwave measurement system.

$163,948—**W. R. Grace & Co.**, Cambridge, Mass., for meteorological balloon.

$34,500—**Western Electric Co.**, Laureldale, Pa., for facilities required in the performance of a production engineering measure for 1000 MC germanium transistor.

AIR FORCE

$11,881,000—**Reflectone Electronics, Inc.**, subsidiary of **Universal Match Corp.**, Stamford, Conn., for electronic "mission training" systems.

$7,450,000—**Vitro Corp. of America**, New York City, for operation, maintenance and engineering of the Eglin Gulf Test Range, Fla.

$2,150,000—**General Motors' AC Spark Plug Div.**, Flint, Mich., for initial provisioning AGE and airborne spares, and spare parts in support guidance subsystem *(SM-68 Titan II B)* missile.

$1,000,000—**Siegler Corp.**, Los Angeles, for design, development and installation of electronic and antenna equipment for space and satellite programs.

$544,500—**University of California (Space Biology Lab.)**, Los Angeles, from Office of Aerospace Research, for studies of brain function and behavior.

$250,000—**Polytechnic Institute of Brooklyn**, N.Y., from OAR, for electromagnetic theory and information processes study.

$249,428—**University of California**, Berkeley, from OAR, for microwaves, solid-state antennas and radiation, bio-electronics, circuits, systems and control.

$165,000—**General Electric's Receiving Tube Plant**, Scranton, Pa., for method of increasing temperature limit of metal-to-ceramic seals from current 150° to 225°C.

$146,085—**University of California**, La Jolla, from OAR, for study of theory of solids.

$121,110—**University of California**, Riverside, from OAR, for investigation of transport processes in transition metal compounds.

$107,649—**Johns Hopkins University**, Baltimore, from OAR, for plastic wave propagation in metals at elevated temperatures.

$101,500—**Duke University**, Durham, N.C., from OAR, for microwave and radio frequency spectroscopy.

$99,884—**Recony Div., Vinco Corp.**, Richmond, Va., for rocket targets.

$73,250—**California Institute of Technology**, Pasadena, from OAR, for study of stellar compositions and related nuclear processes.

$62,905—**Adcole Corp.**, Cambridge, Mass., for design, development, construction and installation of instrumentation for rocket probe ionospheric measurements.

$49,381—**Ionics, Inc.**, Cambridge, Mass., for development of lightweight fuel cell which can be used to generate electric power in satellites and space vehicles.

$27,300—**Boeing Co., Aero-Space Div.**, Seattle, for modification and repair of spare parts for *Bomarc* system; $133,638, prepare time compliance technical order in accordance with engineering change proposal, provide 2 ea. kits, spares and required revisions to technical orders applicable to *Bomarc* weapon.

WHEN HIGH QUALITY *is the Criterion in Airborne Telemetry...*

Vitro Electronics Nems-Clarke airborne telemetry equipment should be the unquestioned choice in applications where proven performance and the utmost dependability outweigh considerations of size and weight. A thoroughly equipped system of this nature might, for instance, have Vitro Electronics Nems-Clarke Type 1403 Airborne Telemetry Receivers. Effective supporting auxiliary equipment in such an installation would include:

Preamplifiers for amplification and improvement of received signals ☐ Multicouplers for distribution of received signals to as many as 8 receivers ☐ Phase-lock telemetry receivers—key units of a system ☐ Diversity-combiners combining reception of up to 4 receivers into one output as good as best single receiver output—or better than equal outputs from all associated receivers ☐ Spectrum display unit to each 4 receivers—for visual monitoring of received signals to determine character and modulation



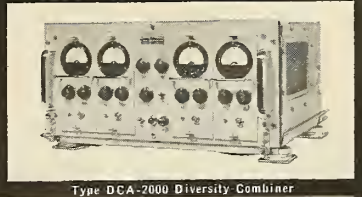
Type PR-202 Preamplifier



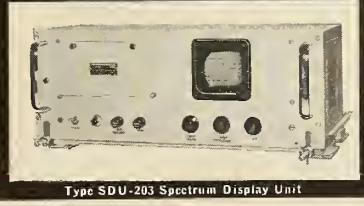
Type MC-202 Multicoupler



Type 1403 Telemetry Receiver



Type DCA-2000 Diversity Combiner



Type SDU-203 Spectrum Display Unit

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Aeronautical and Mechanical Engineers holding B.S. degrees are needed for work in solid propellant rocket development programs in the area of mechanical design, development and testing of rocket motor components and assemblies. At ABL capable Junior Engineers perform evaluations to obtain maximum performance with minimum weight, and do stress analysis of complex rocket and missile structures. These positions entail carrying out design studies of pressure vessels, attachment fittings, release and arming mechanisms and, in particular, advanced design concepts in the utilization of high strength materials for high temperature applications.

All inquiries will be acknowledged promptly. Write to:

Dr. W. R. Lowstuter, Technical Personnel Department

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Cumberland, Maryland



Hercules Powder Company has been actively engaged in research, development and production of rockets and rocket propellants for over 20 years. At the end of World War II, Hercules accepted the Navy's invitation to operate Allegany Ballistics Laboratory, formerly run by George Washington University under NDRC contract.

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All qualified applicants will receive consideration for employment without regard to race, creed, or national origin.

names in the news

Dr. R. M. Wilmotte: Research and engineering specialist in electronic communications, appointed project manager to head Radio Corporation of America's development and construction of the *Relay* experimental communications satellite.

Edward Ray: Appointed project manager of space power; **Victor E. Boccelli,** manager of technical facilities planning, in the Projects Planning and Special Programs Operation of General Electric's Missile and Space Vehicle Dept., Philadelphia.

Dr. Webb Haymaker: Internationally-known neuropathologist, appointed assistant director for Life Sciences, NASA's Ames Research Center, Moffett Field, Calif. Dr. Haymaker also will be director of the Life Sciences Research Laboratory at Ames. He expects to remain at NASA headquarters in Washington, D.C. until he reports to Ames in the fall.

Col. Leslie B. Williams, USAF: Assigned to the Department of State as special assistant for space and atomic energy matters. For the past three years, Williams has served on the aerospace nuclear propulsion and power staff of the Reactor Development Division, Atomic Energy Commission.

Sal LaFaso and S. W. Kerkering: Appointed managers of the Administration and Production Departments, respectively, at Aerojet-General Corp.'s Atlantic Division, Frederick, Md.

Chester W. Nimitz, Jr.: Formerly with Texas Instruments, Inc., elected a vice president of Perkin-Elmer Corp., and general manager of its Instrument Division. **Henry F. Brockschmidt,** general manager of International Operations, and **Robert H. Sorensen,** general manager of Electro-Optical Division, also elected vice presidents of Perkin-Elmer.

Dr. Donald J. Shombert: Formerly with Merck and Co., joins Columbia Broadcasting System Laboratories, Stamford, Conn., as manager of the Electron, Ion, and Molecular Beam Section of the Surface Physics Dept.

Eugene Tatom: Recently retired as Captain, USN, after 30 years service joins United Aircraft Corp.'s Norden Division as chief of research and development.

Vincent P. Huggard: Former assistant chief of the Requirements Division for the Deputy Chief of Staff for Logistics, USA, joins the Washington office of Radio Corporation of America as manager, Army affairs, Defense Electronic Products.

Harmon Q. Avera: Former assistant department head and senior optical engineer (photogrammetric), Itek Corp., ap-

pointed head of the Photogrammetric Research and Development Dept., Bausch & Lamb, Inc., Rochester, N.Y.

Leo W. Killen: Named assistant to the president of Autonetics, a division of North American Aviation, Inc., Downey, Calif. Killen was formerly director of sales and European operations and acting executive vice president for Fairchild Stratos Corp.

Sid W. Farley: Named manufacturing manager, Sparton Electronics Division of Sparton Corp., Jackson, Mich. Prior to joining Sparton, Farley was with Northrop Corp.

Dr. Patrick Conley: Former general manager of the Air Arm Division, elected a vice president of Westinghouse Electric Corp., Pittsburgh, with responsibility for industry engineering apparatus, service and the newly-created industry systems department. **M. B. Wyman** will continue as manager of apparatus products service and **Paul R. Sprowl** has been named manager of the industry systems department.

William A. Sibley and **Michael E. Maes:** Join Rocket Research Corp., Seattle, as research engineers.

A. T. Colwell: Director and former vice president of Thompson Ramo Wooldridge, Inc., elected to the board of directors of The Gabriel Co., Cleveland, Ohio.

Dr. Vee Chang Tsien: Appointed technical assistant to the vice president, Marine Equipment Dept., Nortronics Division of Northrop Corp. Before joining Nortronics, Dr. Tsien was technical staff member at Avco/Rad responsible for development of ICBM control systems.

C. B. McKoewn: Named general manager of B. F. Goodrich Co.'s Aerospace and Defense Products Division. McKoewn formerly was manager of the Aviation Products Division, which has been replaced by the new division.

George B. Espey and **Melvin H. Jones,** research engineers, and **William F. Brown,** chief of the Strength of Materials Branch, NASA's Lewis Research Center, Cleveland, Ohio, received the Charles B. Dudley Medal from The American Society for Testing Materials. The award was presented for a paper of outstanding merit constituting an original contribution on research and engineering materials.

Theodor H. Braun: Appointed vice president and director of plans and operations; **Dr. Launor F. Carter,** vice president and director of research, for the System Development Corp., Santa Monica, Calif.

Pat Minervini: Named engineering manager of Military Electronics Division of Daystrom, Inc., Archbald, Pa. He will be succeeded as chief product engineer by **Bernard Plevyak.**

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- Air Traffic Control System Development
- Computer Technology
- Mathematics
- Antenna Design — Microwave Components

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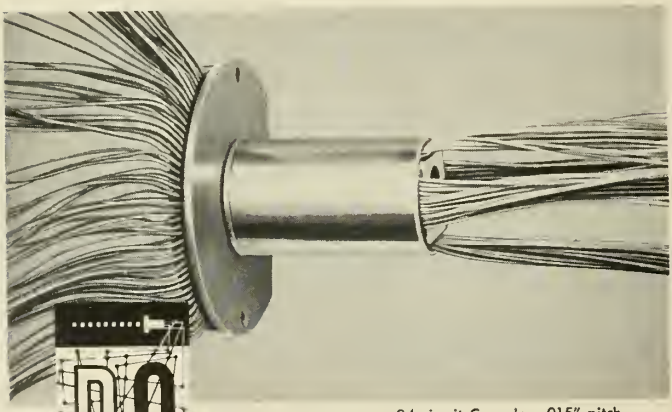
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Poly-Scientific... First In High Density Slip Ring Packaging

By Robert H. Miller
Vice President
Research and Development Division

In inertial measurement units, as in most air or missile borne equipment, space and weight are vitally important factors. As over-all volume is reduced, the size limitations on components become more severe. Micro-miniaturized slip ring capsules pioneered by Poly-Scientific, the use of which is growing steadily, permit great space saving by placing the slip ring under the gimbal bearings, thus utilizing formerly wasted space.

The large number of circuits in multi-gimballed applications require extremely dense axial spacing of slip rings. Advanced techniques permit Poly-Scientific to manufacture by time-tested and proven methods slip ring capsules with ring spacing of .015" pitch. This size reduction is being made without sacrificing high dielectric strength, current ratings, reliability or long trouble-free life.



84-circuit Capsule—.015" pitch

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products and processes

Digital Modules

A line of silicon digital modules which operate at low power and can withstand wide operating conditions is available from the Delco Radio Division of General Motors.

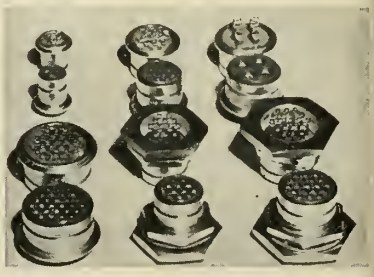
The modules will operate on from 4 mw. to 10 mw. of power per logic stage. Operating temperature range is −10°C to +100°C under conditions of near perfect vacuum, high shock and high humidity.

The basic set of modules includes a bistable multivibrator, a diode NOR gate, a power driver, a monostable multivibrator and an astable multivibrator.

Circle No. 225 on Subscriber Service Card

Hermetic Connector

A quick-disconnect hermetic receptacle with socket-contact insert configurations has been developed by the Deutsch Co. This connector features a full compression glass insert on the rear and a resilient silicone insert in front. The coupling mechanism is of the push-pull, ball-lock type.



Designed for extreme environment applications where a socket insert would be desirable, this connector mates with all plugs in the Detusch DM and DS series. In addition, a complete interfacial seal is obtained when used with the DS series plugs with crimp-terminated, snap-in contacts.

Circle No. 226 on Subscriber Service Card

Inflatable Mobile Antenna

A lightweight, compact, inflatable helical antenna for mobile and transportable tracking systems is available from Andrew California Corp. This 4-ft. antenna, Type 53000-2N, can be put into operation in a matter of minutes with a conventional hand pump.

Incorporating bifilar helices, the gain is greater than 9.5 db over isotropic with a VSWR of less than 1.5:1 across the antenna's (215-265 mc) bandwidth.

Circle No. 227 on Subscriber Service Card

Circuit Analyzer

A circuit analyzer which analyzes from 500 to 18,000 circuit points automatically is available from Autonetics, a division of North American Aviation, Inc. It checks wire continuity of complex electronic circuits automatically by comparing two units against each other. The unit will display steady light patterns to enable qualification of the "master" to wire lists. This equipment eliminates the need for tape or card programing and requires no matrix chart or plug board programing.

Circle No. 228 on Subscriber Service Card

Irradiated Wire

Radiation Materials, Inc. has completed development of an irradiated polyolefin wire and is activating plans for full-scale production and marketing of the material. The irradiated wire possesses radiation resistance, temperature and dielectric characteristics which are especially suitable for the environments encountered in satellite and ballistic missile programs.

The wire's temperature characteristics enable it to resist burning or shrinkback by soldering irons or soldering baths, making it highly applicable to commercial and military miniaturized electronic assemblies where soldering operations in manufacturing present problems.

Circle No. 229 on Subscriber Service Card

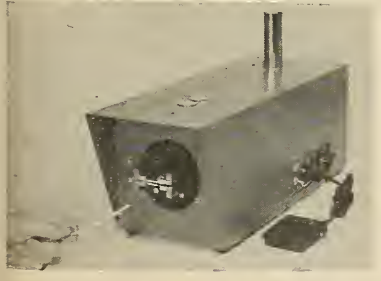
Strain Gage

A fast-setting epoxy cement for strain-gage application has been put on the market by the Instruments Division of The Budd Co. B-3 cement sets in only three hours at room temperature, but heat can shorten this. Feature of the B-3 cement is that, although it sets much faster than standard epoxy cements, it still allows a strain gage to be aligned while cement is setting up, so that it may be positioned with great precision. This also facilitates the use of jigs, fixtures and other tooling.

Circle No. 230 on Subscriber Service Card

Wire Stripper

Western Electronic Products Co. is marketing the Model AT-1 Auto-Therm, a semiautomatic Thermal-type wire stripper capable of stripping over





The first American Astronaut in Space will rely on a continuous supply of oxygen metered through intricate valving which has been designed by Garrett Corporation, AiResearch Manufacturing Division, engineers with the technical assistance of Stillman Rubber Company experts.

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By close coordination with Garrett engineers, Stillman technicians were able to produce this precision part in only four days from the design release date. Stillman's reputation for quality and reliability in the aircraft and missile industry, together with years of technical experience and know-how, enabled them to produce and deliver the all-new, sub-miniature poppet in record time. These same qualities of experience and technical abilities are available to any industry or manufacturer who specifies the very finest of static and dynamic sealing.

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Circle No. 231 on Subscriber Service Card

Boosted Wire Capacitors

Users of Ohmite Mfg. Co.'s tantalum wire electrolytic capacitors can now obtain higher maximum capacitance in most of the existing case sizes. Some of the gains in maximum capacitance are considerable and stem from improvements in processing. For example, the Size E case (.812 x .134 Dia.) has increased from 80 mfd maximum at 1.25VDC to 150 mfds; at 16VDC the increase is from 19 to 25 mfds. The greatest gains were achieved in the larger case sizes and in the lower voltage ratings. The thirteen extremely small case sizes now provide a range from 0.01 to 150 mfds and voltages to 150, depending upon case size.

Circle No. 232 on Subscriber Service Card

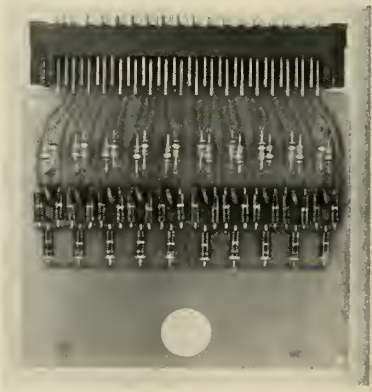
Tape-To-Tape Converter

A versatile tape-to-tape converter for conversion of differing input-output media and codes is available from Daystrom's Control Systems Div. The Daystrom TMTC (Tri-Mode Tape Converter) is available in models to convert perforated paper tape to magnetic tape, magnetic to paper, or paper to paper. The TMTC's accept and generate all paper tape and magnetic tape codes now in use in data processing. Any paper tape data such as accounting records and engineering tests can be read by a TMTC Converter at a speed of 300 characters per second and convert in seconds to magnetic tape for high-speed computer use, re-transmission or storage for future use.

Circle No. 233 on Subscriber Service Card

A-C Coupling Card

Computer Logic Corp. is marketing a plug-in logic coupler card, Model AC-1. The solid-state coupling card is compatible with the 200 kc series of



digital logic circuit modules manufactured by the firm. Useful in ac-coupled digital systems, the Model AC-1 allows a reduction in the number of basic digital logic cards used in the system. The coupler card is also used in triggering one-shot delays.

Circle No. 234 on Subscriber Service Card

Regulated Power Supply

A solid-state regulated power supply with automatic voltage-sensing and an input-output efficiency nearly 50% higher than that of comparable equipments is being marketed by Weber Electronics Division of Weber Aircraft Corp. Used for powering components on ready-to-fire missiles, the unit employs safety factors to sense remote

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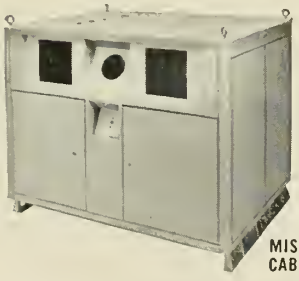
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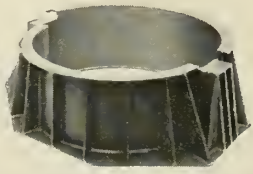
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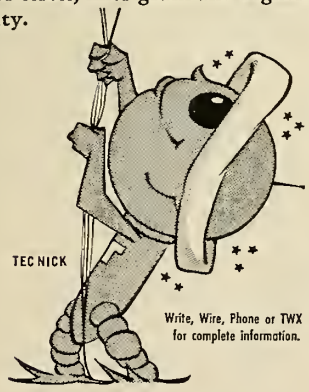
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malfunction and to regulate (locally and at load), or to shut off power in the event of over-voltage or over-current at the load.

The rack-mounted power supply has separate electronic and magnetic overload-sensing systems; either can independently sense voltage and current, and function to adjust or shut off as required.

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Dry-Film, Bonded Lubricant

Molykote X-15, an inorganic-bonded, dry film lubricant with a useful temperature range of from −300 to +1200°F is being produced by The Alpha-Molykote Corp. under a licensing agreement. In addition to its wide temperature range, Molykote X-15 is insensitive to liquid oxygen; has proven to be unaffected by up to 5×10^6 roentgen gamma radiation; retains its lubricating properties under vacuums up to 10^{-9} mm of Hg; and is easy to apply in either shop or field.

Circle No. 236 on Subscriber Service Cord

Direct Drive Counter

A line of high-performance, low-torque, direct-drive counters for digital readout applications where plus and minus, right and left, or directional readings are required is available from Veeder-Root, Inc. Designed for applications in navigation instruments, missile ground support equipment, ground approach systems, machine tool indicators, gauging instruments, and tracking equipment, the line will include 27 different units both in-bank and in-line models.

Circle No. 237 on Subscribor Service Cord

Data/Photograph Correlator

A digital recording head for correlating digital data and photographic images on the same photographic film has been developed by FMA, Inc. Mounted inside a camera, the miniature device provides a means of recording instrumentation data such as test parameters (e.g., velocity and temperature) along with the photography normally required in such operations as missile-testing, sled-testing, or destruction tests. The problem of synchronizing and collating several recording media is thus eliminated. Instrumentation data are directly associated with the pictorial recording.

Circle No. 238 on Subscriber Service Card

Portable Antenna

Temco Electronics Division of Ling-Temco Electronics, Inc., has available a lightweight, 4- or 7-turn helical antenna. Gain, at center of band, is 10.5 decibels at 4 turns, 13.5 decibels at 7 turns. Beam width is 52° and 40° at same specifications. Impedance is 50 ohms,

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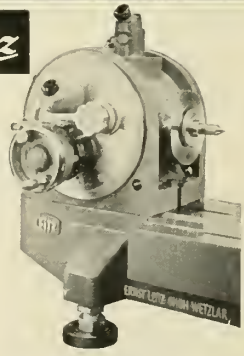
© 1961 Frontier Electronics Co. 4612 Memphis Avenue • Cleveland 9, Ohio.

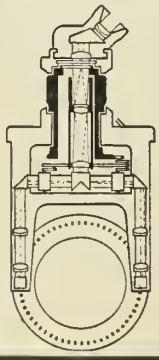
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Ultra Precision Spacing on guided missile components and similar critical work guaranteed by this exclusive DOUBLE-MICROSCOPIC PICK-UP of the LEITZ OPTICAL MASTER DIVIDING HEAD.





It compensates for run-out, the most common source of error. Working accuracy ± 1 second of arc.

There is no substitute for LEITZ in optical dividing.

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...products and processes

and voltage standing wave ratio is less than 2 to 1. Frequency range is 215 to 265 megacycles per second, with other frequencies available upon special order.

Circle No. 239 on Subscriber Service Card

Front-Feed Printer

A digital printer with an all-transistorized drive is available from Computer Measurements Co. The Model 400DT has a convenient, simple and easy-to-read front-tape feed and can be either cabinet- or rack-mounted. The digital



printer can be coupled to any electronic counting equipment or control system that provides a 1-2-4-8 binary coded decimal output with a voltage swing of −6 volts. It is designed to operate directly with any of the CMC solid-state digital instrumentation.

Circle No. 240 on Subscriber Service Card

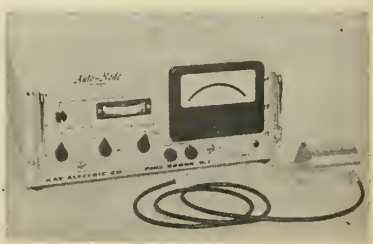
Midget Heat Sink

Hunter Tools is now producing a small, lightweight heat sink. It is 1¼ in. long and has slimmer points to get into confined areas. These heat sinks are made of Berylco 10 because of its high thermo-conductivity and good spring characteristics. The handles are covered with plastic to keep finger area cool and comfortable.

Circle No. 241 on Subscriber Service Card

Noise Figure Test Set

The Auto-Node, an accurate, wide-range noise figure measurement test set, is available from Kay Electric Co. The unit provides highly precise noise figure measurement from 0 to 15 db at



frequencies from 5 to 2000 mc. It contains all the necessary equipment for making noise figure measurements. An I-F range of 7.5 to 150 mc (with a required input noise level of −10 db to 0 dbm over a 3-mc bandwidth) is provided. The I-F frequency covers the range of most I-F's presently used. The AGC has a dynamic range of 12 db.

Circle No. 242 on Subscriber Service Card

Nose Cone Grinder

A dual-table contour grinding machine using a three-dimensional master is available from Frauenthal Division of the Daydon Engineering Corp. An automatic electro-hydraulic tracer system using a master on the first table produces a duplicate on a second table and within ±0.0005 in. For other applications, a grinding spindle may be added to use with the second table for grinding two identical parts, one on each table. The Model 926 machine was designed to grind Pyro-Ceram nose cones, but may be adapted for other parts.

Circle No. 243 on Subscriber Service Card

Cold-Wall Vacuum Furnace

A line of standard high-temperature cold-wall vacuum furnaces able to produce temperatures up to 2500°C at $1x10^{-5}$ mm Hg pressure has been developed by Vacuum Specialties, Inc. Designed for high-temperature materials research, development, and production programs in the electronics, space, and nuclear fields, the new line consists of 27 models in nine different sizes. The units employ internally heated hot zones which may be arranged either vertically or horizontally. Sizes range from 60 to 2700 $in.^3$.

Circle No. 244 on Subscriber Service Card

Silicone Wire Insulator

A silicone rubber compound, SE-9007, for use as wire and cable insulation has been put on the market by the Silicone Product Department of G.E. Similar to the SE-975 family of compounds, the material is designed primarily for high-quality aircraft, hook-up, motor lead and similar wire applications. It is somewhat softer than SE-975 grade, offering excellent processing characteristics, easy milling, high extrusion speeds and very good diameter control.

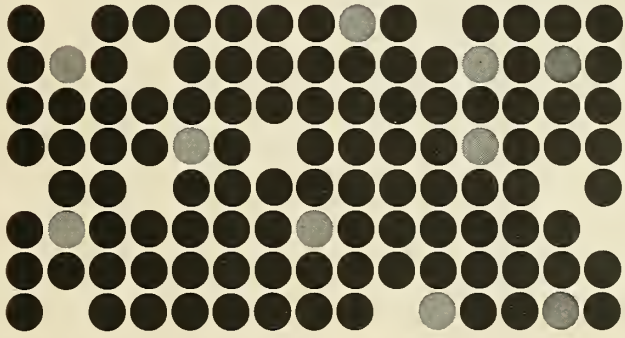
Circle No. 245 on Subscriber Service Card

Monitoring Transformers

A line of transformers for precision monitoring of pulse currents at voltages up to 300 KV has been developed by Pearson Electronics, Inc. These units are used with a standard oscilloscope for monitoring of pulse currents from milliamperes to tens of thousands of amperes in high- or low-voltage conductors, charged particle beam currents

SUPERVISOR

IN THE FIELD OF DIGITAL DATA TRANSMISSION



IMPORTANT to any creative engineer is the opportunity to tackle an unusual problem—then see his own ideas progress from conception to a fully operational system.

Just such an opportunity is now available at the Weather System Center for an engineer experienced in the area of digital data transmission via land communication lines. The individual selected will supervise and direct: 1) investigations and analysis of present and planned message traffic on civilian and military weather circuits. 2) study both high-speed and low-speed digital data and graphic circuits. 3) design an improved communication system to Government specifications. 4) evaluate communication equipment and procedures to obtain efficient system design at reasonable cost.

Because of the pioneering nature of the project, this position offers exceptional challenge and opportunity to a truly creative engineer capable of originating major design concepts. It can be an introduction to a satisfying lifetime career in a new field with unusual growth possibilities.

Minimum requirements: Engineering degree preferably in electrical or communication engineering. Eight to ten years experience with emphasis on experience in the digital communications area.

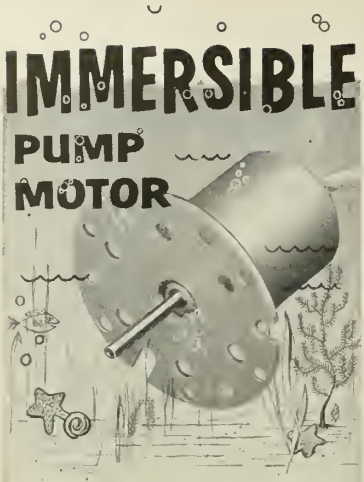
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UNITED AIRCRAFT CORPORATION/EAST HARTFORD, CONN.

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Fully Approved
for use with FC-75 and other exotic fluids

A version of this highly reliable pump motor is currently serving on A. C. Spark Plug's all inertial guidance system.

The unit is fully compatible with fluorochemicals and will not contaminate such fluids.

A wide choice of voltages to suit the application, as well as some of the lowest watt inputs possible to achieve the task.

But perhaps the most remarkable feature of the Calco immersible pump motor is its tremendous endurance.

Tested under duplicated service conditions, this pump motor has functioned continuously for over 10,000 hours without failure or dimensional wear. This, gentlemen, is reliability.

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Precision electro-mechanical components for airborne and ground support equipment. WRITE FOR INFORMATION

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in accelerators, and electron currents in electronic devices. The specifications feature fast rise-time (20 millimicroseconds), low droop (0.1% to 0.0005% per microsecond, depending on model), high-output amplitude accuracy (+1%, −0%), and ability to monitor currents at very high voltages up to 300 KV.

Circle No. 246 on Subscriber Service Card

L-Band Coaxial Isolator

Miniature L-band Coaxial Isolators with improved electrical characteristics are available from E & M Laboratories. These units, 6.45 in. long and less than 2 lbs. in weight, have been reduced to one-half the previous size. Standard units covering the frequency range of 1.0 to 2.0 kmc/s have a 10:1 isolation/insertion loss ratio and a VSWR of 1.15 maximum. Narrower band units are also available with much higher isolation/insertion loss ratios.

Circle No. 247 on Subscriber Service Card

Tracing Attachment

True-Trace Corp. has available the Mark X tracing attachment for vertical turning and boring machines. A feature that further enhances the versatility of machine tools is the Mark X VTL tracing attachment which converts a vertical



turning and boring machine into a contour turning lathe. This compact attachment mounts to the ram or turret of the machine, or many be installed in place of the side head—depending upon the individual machine and job requirements. Being an attachment, no machine conversion is required.

Circle No. 248 on Subscriber Service Card

Rotary Accelerator

Pacific Southwest Instrument Laboratories is marketing a rotary acceleration generator designed for test qaulification programs and production testing. The 20-in.-diameter spin table, designated as Model RA-ATC-500-1 tests dynamic characteristics of instruments and other scientific objects from 3 g to 500 g/lbs. The rotary acceleration gen-

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MODEL 200 - 13 BIT ACCURACY

Compact Type 23 synchro-mount with NO BRUSHES, NO GEARS, LOW TORQUE. Steady light up to 20 rpm. Diameter: 2.6", Length: $3\frac{5}{16}$", Weight: 1.25 lbs.



MODEL 202 - 13 BIT ACCURACY

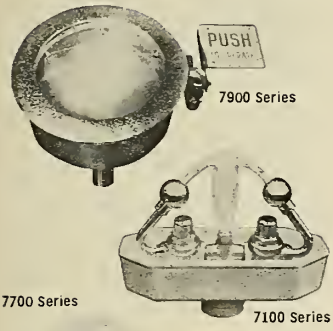
Compact Type 23 synchro-mount with flashing light up to 500 rpm. Low torque with no brushes or gears. Diameter: 2.6", Length: $4\frac{7}{8}$", Weight: 1.7 lbs.

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erator employs dual controls to provide an infinite variable platform speed within an operating range of from 10 to 2000 RPM. The course RPM speed is established by an initial control setting while a second control provides fine RPM trimming.

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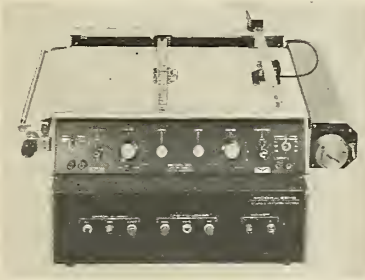
Telemetering Transmitter

Wiley Electronic Products Co. has developed a telemetering transmitter for use in rotors of high-speed rotating machinery. Data is transmitted on the subcarrier oscillator frequency directly, with no RF carrier, through capacitively coupled non-contacting slip rings. No FM-FM receiver is required, and the subcarrier frequency deviations of ±40% are readily obtained without complication. The transmitter is a bridge-controlled, subcarrier oscillator for use with strain gage bridges.

Circle No. 250 on Subscriber Service Card

Time Delay Simulator

Model 2D-5 Transport Delay Simulator is an instrumentation system which easily reproduces any time delay encountered in a process control or experimental laboratory situation. Developed by F. L. Moseley Co., the system



combines a standard Autograf Model 2D-X-Y Recorder with its roll chart accessory and a Moseley Type F-2 Line Follower carried on the recorder's second arm. Any function can be recorded by the recorder's writing pen and, at any desired time later, can be read back by the line follower.

Circle No. 251 on Subscriber Service Card

Film Shift Registers

Servomechanicms/Inc. has available thin magnetic-film shift registers. The registers exploit a magnetic domain interaction or domain boundary-extension phenomenon inherent only to magnetic films. This phenomenon, which allows the action of infinitesimal magnetic dipoles within the film and their interactions upon each other to be controlled, yields shift registers in which the data processing is performed completely inside the film.

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R/M ASBESTOS-PHENOLICS

molded stock saves tooling up for prototype parts

Why pay for expensive dies and equipment for molding high-temperature test parts of reinforced plastics? Machine them from standard rods and tubes available from R/M in a broad range of sizes.

R/M asbestos-phenolic molding compounds have proved themselves in the hot spots of virtually every U.S. missile. They exhibit uniform ablation at extreme temperatures for nose cone or rocket engine environments. And they assure high strength-to-weight ratio, structural integrity and shock resistance, and low thermal conductivity and diffusivity.

The superiority of R/M Pyrotex® molding compounds stems from the use of extra-long spinning grade asbestos fibers.

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Platinum Plating Bath

Technic Platinum T. P., a commercially practical bright, hard, pore-free platinum plating bath, is available from Technic, Inc. Pore-free deposits above 0.0001 in. can be plated easily with the bath. The bath is stable over broad operating conditions and porosity is negligible even for deposits only 0.000050 in. thick. Because of its brightness and the inherent properties of platinum, it is suited for use as an electrical contact surface.

Circle No. 253 on Subscriber Service Card

Push-Pull Couplings

A rugged series of quick-connect-disconnect couplings which sustain operating pressures up to 3000 psi is available for applications ranging from electronic cooling to hydraulic systems from E. B. Wiggens Oil Tool Co., Inc. Available in eight models, the series (called Inst-O-Matic) withstands vibrations of 20 g's at 2000 cps. Coupling disconnects under pressures of 3000 psi and connects under pressures of 50 psi.

Circle No. 254 on Subscriber Service Card

Micro Volt-Ammeter

An electronic (all-Transistor) d-c micro volt-ammeter operated by an automatically recharged nickel-cadmium battery is available from Dynamics Instrumentation Co. The Model 4072 has full-scale ranges of voltage from 100 microvolts to 1000 volts, and current from 10 millimicroamperes to 1 ampere. Accuracy on all ranges is ±1% of full scale. The overload protection circuit makes it possible to safely apply up to 100 volts on the microvolts ranges, and 1000 volts on the upper ranges.

Circle No. 255 on Subscriber Service Card

High Speed Light-Pulse

Unilectron, Inc. is marketing an ultra-high-speed flash source called the "Sync'd" Submicrosecond Light Pulse Generator. This unit provides a single, point-source light pulse of high intensity with a duration as short as 0.3 microsecond. Four models provide energy levels from 2 to 20 joules with durations from 0.3 to 1 microsecond. Point-source size ranges from 0.015 to 0.060 in. diameter, depending upon energy level.

Circle No. 256 on Subscriber Service Card

Separate Output Sequencer

A versatile sequencer designed to produce signals on separate output lines at a rate equal to the input clock is available from Alpha-Tronics Corp. Type SSL-101 utilizes a d-c start for



PART MAKERS TO MISSILE MAKERS

As the initial flight test of the Minuteman revealed the success of America's first solid propellant ICBM, we at Fenn took an extra measure of pride in our precision parts in the vector nozzles.* It added missile components to a long list of other precision Fenn-made parts that fly. If you need a reliable source . . . with long experience . . . completely modern facilities and thinking, we would like to tell you more about Fenn. Copies of our Facilities Folder and Facts About Fenn are yours for the asking. The Fenn Manufacturing Company, Fenn Road, Newington, Connecticut.

*Vector nozzles designed by Arde-Portland for the Thiokol first stage rocket engine.



FENN

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Circle No. 26 on Subscriber Service Card



developing the first output. The logic incorporated into the design will prevent more than one output being energized at one time, thereby eliminating the possibility of any false signals. This logic will also enable one sequencer to drive another in a decade fashion, and still prevent the appearance of more than one signal simultaneously on either deck.

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Power Measuring Device

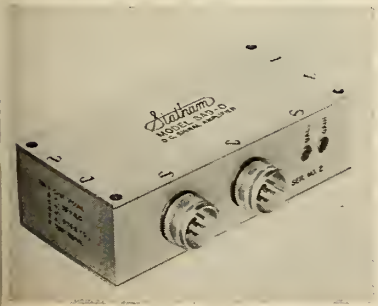
Consolidated Aviation Equipment, Inc., is marketing a solid-state power sensor which provides an in-line measurement of true power over a wide frequency range extending from d-c into the very high frequency region. True power of complex waveforms is measured. Several models provide sensitivities enabling a measure of power ranging from the order of a few milliwatts to many hundreds of watts. The insertion loss of the device is negligible and it is physically small.

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Hi-Gain Signal Amplifier

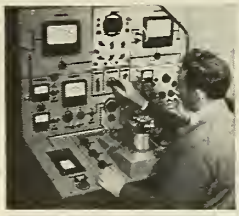
A transistorized, high-gain airborne d-c to d-c signal amplifier is available from the Electronics Division of Statham Instruments, Inc. The SA9-O signal amplifier features higher gain, a wider temperature range, smaller size and excellent stability. The unit provides complete utilization of low-level d-c signals from thermocouples, thermal sensing to bridges, and d-c excited transducers. It has been designed to operate under extreme environmental conditions.

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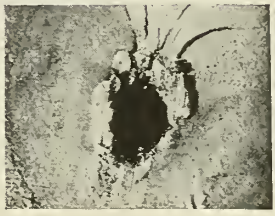




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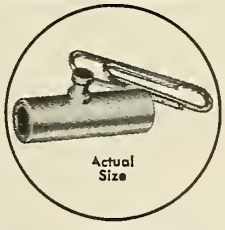
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- **Weighs less than 1/5th of an ounce!**

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MILLIMITE SPECIFICATIONS:

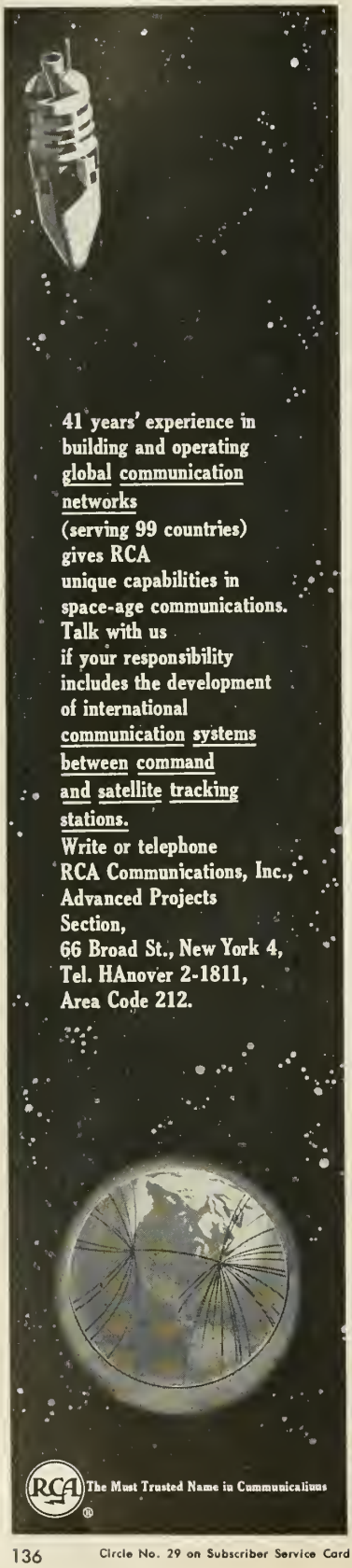
General: SPST, unidirectional, normally open
G Range: to 250 G's, Factory calibrated and sealed at any point
Accuracy: ±10% (closer tolerances on request)
Damping: Undamped
Reset: Automatically resets when acceleration is removed
Electrical Rating: 1 amp @ 28V DC
Terminals: 1 pos. and 1 case ground
Temperature Range: —65° to +250°F



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—when and where—

JULY

Fourth International Conference on Medical Electronics Combined with 14th Annual Conference on Electronic Techniques in Medicine & Biology, Waldorf-Astoria Hotel, New York City, July 16-21.

Western Plant Maintenance and Engineering Show, Pan Pacific Auditorium, Los Angeles, July 18-20.

Structural Engineering Aspects of Atomic Shelter Seminar, Pennsylvania State University, University Park, July 23-Aug. 4.

AFOSR, Differential Equations in Nonlinear Mechanics, cosponsored with Martin's RIAS, Air Force Academy, Colorado Springs, Colo., July 31-Aug. 4.

Physics of the Solar System and Re-entry Dynamics, National Science Foundation, NASA, Virginia Polytechnic Institute, Blacksburg, July 31-Aug. 11.

AUGUST

Space Age Astronomy, symposium sponsored by Douglas Aircraft Co., Cal-Tech, Pasadena, Aug. 7-9.

American Rocket Society/Stanford University Guidance and Control Conference, Stanford University, Palo Alto, Calif. (some sessions classified), Aug. 7-9.

Society of Photographic Instrumentation Engineers, 6th Annual Technical Symposium, Ambassador Hotel, Los Angeles, Aug. 7-11.

Survival in the Nuclear Age-Executive Management Seminar, Pennsylvania State University, University Park, Aug. 13-18.

International Astronomical Union, 11th General Assembly, Pasadena, Calif., Aug. 15-24.

American Rocket Society International Conference on Hypersonics, Massachusetts Institute of Technology, Cambridge, Aug. 16-18.

National Naval Aviation Meeting, Institute of the Aerospace Sciences, San Diego, Calif., Aug. 19-24.

Welded Electronic Packaging Association Symposium, Lockheed Missiles and Space Division's Palo Alto Research Facility, Calif., Aug. 21.

National Academy of Sciences 10th Pacific Science Congress, University of Hawaii, Honolulu, Aug. 21-Sept. 8.

Western Electronics Show and Convention (WESCON), Cow Palace, San Francisco, Aug. 22-25.

American Rocket Society Fourth Biennial Gas Dynamics Symposium, cosponsored with Northwestern University, Technological Institute, Evanston, Ill., Aug. 23-25.

American Institute of Electrical Engineers, Pacific General Meeting, Salt Lake City, Aug. 23-25.

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- Valves
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Geneva, Switzerland—10 Rue Grenus; Geneva 321044

Paris, France—11 Rue Condorcet; TRU 15-39

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Increasing Activity on Planet Earth

EXPANSION of the missile/space industry internationally is evident in the pages of this annual encyclopedia issue. More nations are building more missiles and space probes than ever before.

Limitations of national budgets will prevent most countries from ever undertaking individual space exploration on a scale comparable with that of the United States and the Soviet Union.

But two developments abroad are fostering a growth of missile/space interest. One is the pooling of national resources as in the European Space Club. The other, a realization that weather probes, small satellites and tactical missiles are not out of the financial reach of a number of countries.

West Germany's decision to participate in the European cooperative satellite launching program lifts a major obstacle from its path. There are others still to be met if the project is not to degenerate into a Tower of Babel due to language difficulties, differing engineering standards, varying national goals and the normal confusion generated when you put an Englishman, a Frenchman and a German in the same room.

A nation of West Germany's diverse industrial talents can be expected to move swiftly in the missile/space field now that a start has been made. As noted in our special report on the Paris Air Show, West Germany made its debut there in the postwar space field with a modest sounding rocket. Others are under development. Now comes the decision to join the European Space Club.

When the day comes, will Germany's wartime opponents express concern at some point over the size of German rockets built to lift peaceful satellites and space stations into orbit—but which are capable of lifting other things? Probably. And undoubtedly do nothing about it. So we anticipate in the years ahead a significant resurgence of German interest in the missile/space field.

Britain, in addition to the large role it is expected to play in the cooperative satellite launching program, has a number of other projects under way. A British payload for ionosphere measurements is to be placed in orbit by a NASA *Scout* next year. A second British satellite is to be launched in 1963 by a *Scout*. Considerable work is being carried out by British sounding rockets launched in Australia.

Canada is undertaking an extensive series of ionosphere probes and the launch of an earth satellite in 1962.

The Soviet Union has outlined a long-range space program which includes surveillance satellites in polar orbit, earth-orbiting space stations, two manned moon vehicles and reconnaissance rockets to each planet.

Whether all these efforts abroad can be greeted with equanimity, only the years ahead will tell. But there is one cloud on the international horizon which requires some immediate thought.

THAT IS THE THREAT of a "weather rocket" war between Israel and the United Arab Republic. Successful launch of the Israeli rocket coupled with official comments on "grave defense problems" which gave it priority brought immediate disclosure that Cairo is purchasing weather rockets in the U. S.

If it were not so serious, the prospect of the Israelis and the Arabs lofting weather rockets at each other might be sufficiently amusing to provide the plot for a comedy starring Alec Guinness and Peter Sellers. But anyone who watched the Israeli rout of the Egyptians in the Suez fighting is well aware of the deep feelings which still smoulder in that region. Hot tempers and launch pads are a poor combination. Some serious thinking should be done before approval is given to private firms to ship these rockets off to Cairo. It is not an easy problem for the State Department, which must decide whether to grant the export licenses.

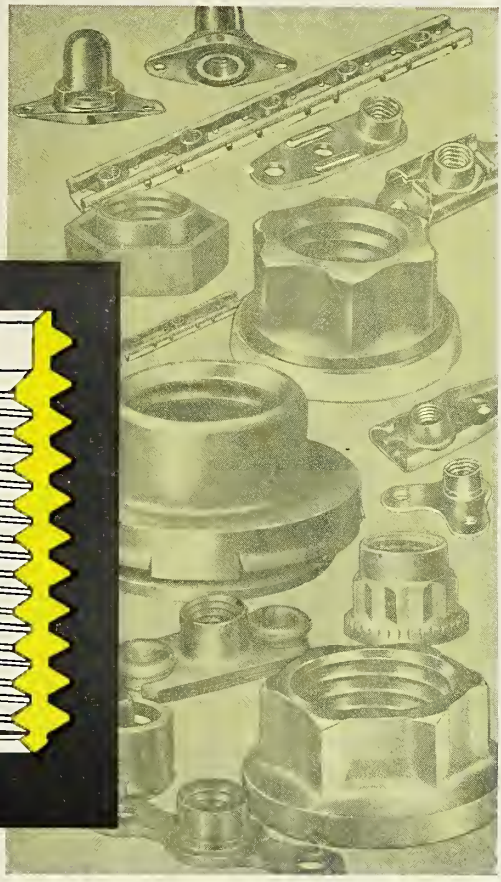
But it certainly emphasizes our point that there is a growing interest abroad in missile/space activities.

William J. Coughlin

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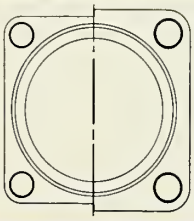
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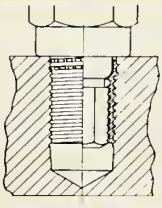
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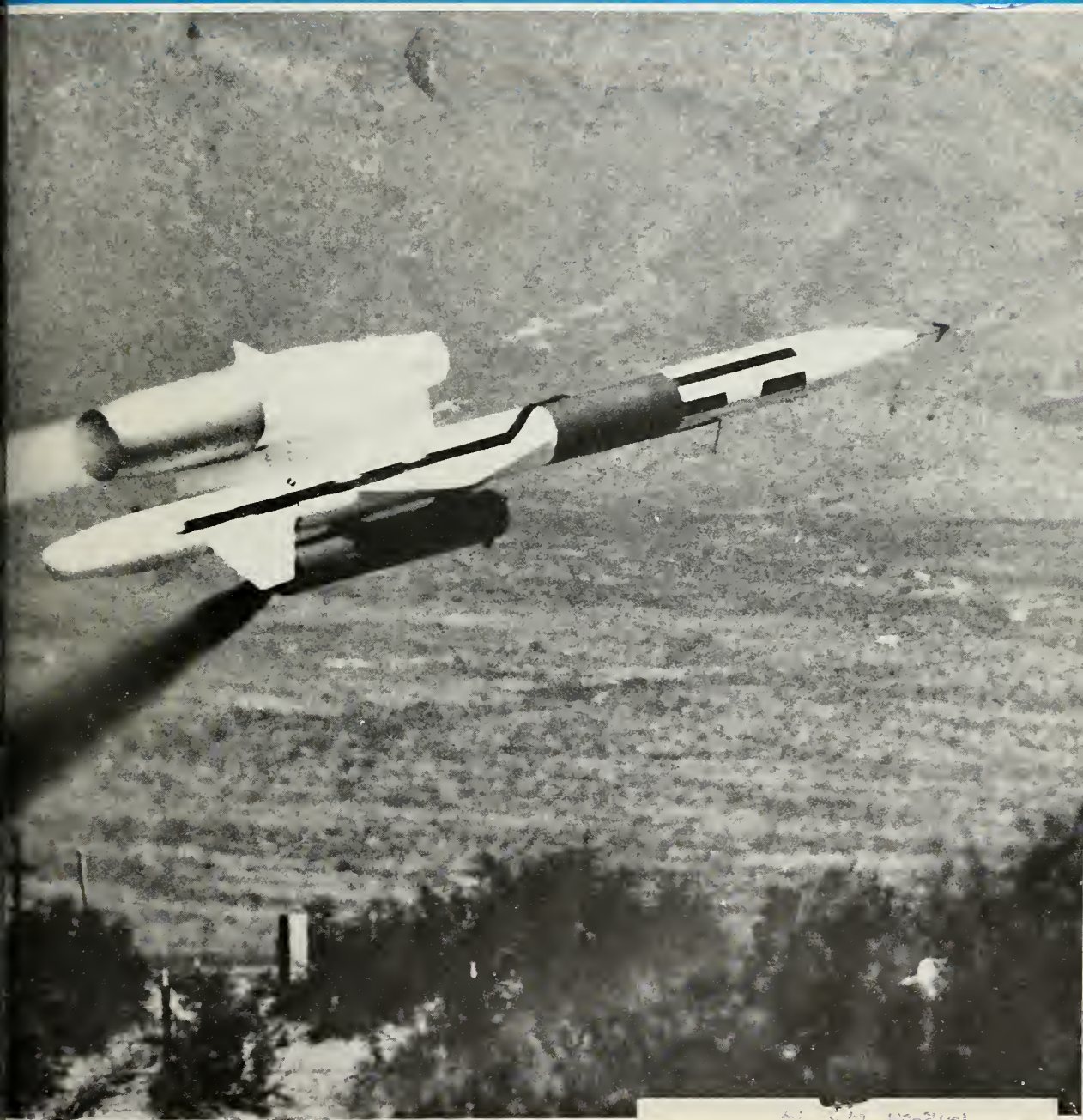
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THE MISSILE/SPACE WEEKLY

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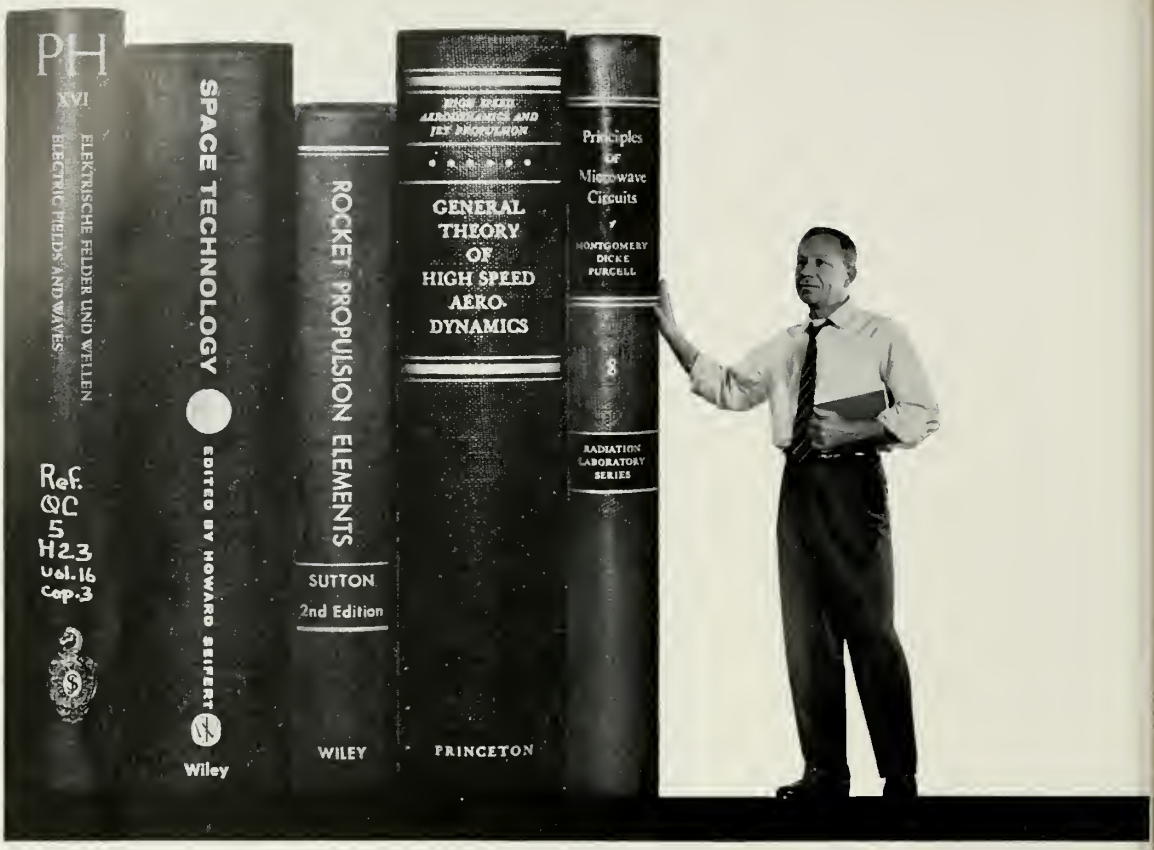


Testing the Army's Redhead/Roadrunner Target

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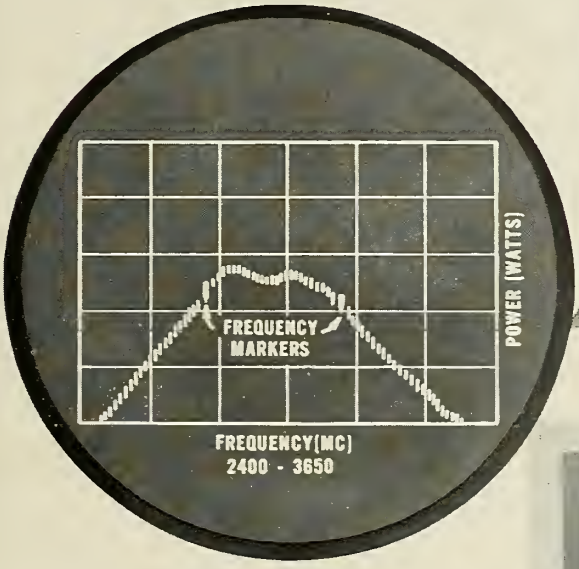
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missiles and rockets

Volume 9, Number 4 July 24, 1961

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THE COVER

Army's newest supersonic target missile, the North American Redhead/Roadrunner, shown in recent successful firing at White Sands Missile Range, N.M. See p. 32.



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† U.S. Reg. Pdg.

35,193 copies this issue

Is Defense Advertising Necessary?

There has been a lot of talk lately about the cost of the advertising done by defense contractors. One prominent Senator recently said he was greatly disturbed over heavy defense advertising expenditures. He pegged the cost "to the taxpayer" at $500 million.

This figure is many, many times the actual total of defense advertising expenditures and only a fraction of that total is recoverable. The Senator's facts are wrong; but, even more disturbing, it appears that he doesn't understand the purpose and function of sound advertising. He considers this money down the drain and thinks it should not have been spent.

There are other instances demonstrating a growing wave of anti-advertising sentiment in high government places. They indicate a lack of understanding and represent a threat both to freedom of the press and success of the Nation's defense goals.

We publish specialized business magazines and reference books. Several of these are defense oriented. They perform communications functions essential to our national goals . . . more essential now than ever before because of the complexity of today's technological and political challenges. There are other excellent magazines having the same or similar purposes. We're delighted—because competition is healthy and because there is more to be done than can be handled by any one of us.

Virtually all publications are financed, by and large, by advertising. This is healthy, too; but it is not the primary reason for defense advertising.

We believe that advertising is an effective and necessary tool for the defense contractor. The objectives of defense advertising are many: some of them obvious, others more subtle.

Sales is one obvious objective. It can be demonstrated that advertising, for some defense products, has led directly to sales. In other instances, selling is a long, complex process, where features of current products may not be as important as company reputation. In both cases, the government wants competition for defense contracts—by use of a competitive bidding system, it gets better products for less money. How is a company to compete if it is not allowed the use of sales tools—one of which is advertising?

Recruiting is another obvious objective. Will that engineer who is inspired to contribute to technological advancement in the missile/space age, for example, be interested in learning more about the kind of company he goes to work for? You bet he will, and more power to him.

The dissemination of technical information is a third, and perhaps the most important, objective. The exchange of such information is one of the biggest problems facing both government and industry. And what more effective, more economical means of disseminating necessary technical information exists than the business press? Mills Shepard, who performs readership studies on one of our publications, reports that advertisements are often read as avidly as the editorial pages. And Eastman Research, in a study released May 29, based on more than 100 surveys for 32 business-paper clients over a two-year period, reports that *70% of the readers interviewed read the advertising in these businesspapers on purpose.*

There are many other equally important objectives. Companies must raise capital in order to be able to do the jobs that need doing for defense. Good community and employee relations are considered necessary to a company's well-being. These and other objectives have been effectively achieved by defense contractors through advertising.

The defense industry is made up of numerous private companies facing the tremendous challenge of meeting, in cooperation with the government, our national technological goals. To meet this challenge, the companies must be strong and healthy. To deprive them of the use of effective and honest advertising is shortsighted and wrong.

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—letters—

And 'Reverse Oidorites'

To the Editor:

Reference M/R, June 12, p. 15, to correct and clarify your definitions (of "meteorite" and "meteoroid"):

Meteoroids—while *outside* the earth's atmosphere.

Meteors—while *passing within the* earth's atmosphere.

Meteorites—*after striking* the earth's surface.

The *S-55* might be called a "reverse oidorite."

M/R is one of the few technical publications I *find* time to read thoroughly.

The "Astrolog" is especially well done and informative. Suggestion: In the column headed "Project" could you add a small *outline* drawing of the unit.

G. V. Plachy
F.R.A.S., Assoc. Fellow, A.A.S.

Mr. Plachy is of course correct regarding meteors, -oids and -ites. As for line drawings in the Astrolog, this is not feasible at present. We'll keep it in mind.—Ed.

Mostly Not Guilty

To the Editor:

I like your magazine in general and I was a charter subscriber. However, I cannot allow errors of the type on page 9 of M/R, July 10 (to) go unchastized (*sic*). Specifically, the errors in the items "Lunar Exploration Reshuffle" and "European 'Space Club' Set." In the first, you have used the adjective "quicker" instead of "more quickly." In the second, you have used "to participating" instead of "to participate." Also, on page 11, in an item headed "Marshall Set to Expand," you use "to over" instead of "to exceed."

While I realize that many changes have occurred since I studied grammar in grade school, I don't believe that today's teachers condone such barbaric grammar. Much has been written of the inability of the professional engineer and/or scientist to communicate with the laity. The examples cited above indicate that even prominent technical magazines should send their copyreaders to school.

Stanley V. Castner
The Marquardt Corporation
Van Nuys, Calif.

We feel only slightly chastised. Webster says "quick" and "quicker" are adjectives as well as adverbs. He also says that "over" has a legitimate meaning of "more than" or "exceeding" (we used "budget will double—to over $800 million . . ."). In the other item referred to, M/R reported that "West Germany has agreed in principle to participating in (the European joint space program)." According to the Library of Congress, it would have been correct to say "agreed . . . to participation in," in the intended sense of accepting the basic idea. The gerund form—"participating"—is a verbal noun. But we probably should have used "participation." Whew! —Ed.

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The Countdown

WASHINGTON

NASA's Dilemma: How 'Big?'

NASA's top command is having second thoughts on just how "big" a man to put in charge of the *Apollo* man-to-the-moon program (M/R, July 17, p. 56). The dilemma: the program is certain to absorb most of NASA's annual budget in the years ahead. So any public personality picked to run the show is equally certain to overshadow the NASA top command itself.

Polaris Subs: No. 20 through 29

The Navy is understood to be ready to let contracts for construction of all 10 of the latest *Polaris* submarines planned by the Administration as soon as Congress passes the FY '62 appropriations bill. The submarines will bring to 29 the total number in the *Polaris* fleet commissioned or building. Latest price tag on a Polaris sub: $116.2 million—about $78 million for the submarine and $38 million for *Polaris* system equipment.

Polaris Bases: Pacific Division

Polaris submarines operating in the Pacific will load their missiles at Pearl Harbor and undergo overhaul at Puget Sound, Wash. The *Polaris* Depot at Pearl Harbor will be similar to the one near Charleston, S.C. The Navy long-range plans call for deploying two *Polaris* squadrons—18 submarines—in the Pacific.

Improved CBR Delivery Sought

The Army is quietly pumping more funds in FY '62 into developing improved means of delivering chemical and bacteriological warheads. Possibly as much as $100 million may have been set aside for developing drone carriers alone. The Army has expressed increased alarm over the Soviet buildup of CBR weapons.

ICBM Base Lessons Learned

Air Force officials feel that ingrown slippage in the ICBM base-building program has finally been brought under control. Although it is too late to make up much of the time lost to date, *Titan II* and *Minuteman* base construction are expected to move ahead on schedule thanks to much experience hard-won by the Air Force, Army, Industry and the Administration.

On the Pad

The Air Force is planning to fire its third *Minuteman* this week from the Cape. Also on tap: a *Blue Scout* and NASA's first *Ranger* lunar hard-landing vehicle tryout aboard an *Atlas*. A *Samos* is set to go from Point Arguello, Calif. (See p. 14.)

Who'll Go to the Moon?

It will be a year or two before NASA gets around to picking more astronauts for the *Apollo* program. The number will be increased to 40 or 50 above the seven picked for *Mercury*. Three-man *Apollo* crews are expected to include two pilot-engineers and a pilot-scientist in charge of the landing party to obtain samples of the lunar crust and other data.

INDUSTRY

Small Business for Ivan, Too?

Some military procurement officers are disturbed at new Kennedy Administration policies to give more defense work to small business. They feel that "anybody" can now obtain specs on many pieces of hardware. Says one official: "The 'contractor' might be a Russian agent, for all we know. He's not investigated until he returns a bid."

AF Overhauling Rocket Engines

The Air Force's San Bernardino Air Materiel Area, Norton AFB, Calif., has completed its first in-house overhaul of a *Thor* engine and shipped it back to England. The engine is the first of 400 programed for SBAMA overhaul through 1964. *Atlas* and *Jupiter* engines will come in from operational bases starting next month.

Proposed Solid Upper Stage

United Technology Corp. says its new fiberglass-cased solid rocket, if used as an upper stage, holds possibilities for increasing payload weight significantly. Performance of the 7 ft.-long, 18-in. motor containing 850 lbs. of propellant: I_{sp} in space—275; mass ratio—0.94; thrust—6000 lbs. for more than 30 sec.

R&D Intelligence

Astro-Rocket Inc. (Talley Industries Inc. subsidiary) has a process for casting rather than extruding ammonium nitrate for a new solid propellant. The low-energy, long-burning fuel will be used to actuate *Titan II* ICBM silo hatches. . . . AF has awarded Dynatech Corp. a contract for designing a 3000°F thermal conductivity measurement device to be used on super-alloys, honeycombs, cermets and ceramics.

INTERNATIONAL

Bloodhound Edges Out Hawk

COUNTDOWN hears the losing competitor in the Swiss deal for $84 million worth of Bristol/Ferranti *Bloodhound Mark II's* was the Raytheon *Hawk*. Sweden recently purchased about $66 million worth of *Bloodhounds*.

Overseas Pipeline

Expect the French Space Agency to set up a launch site on the French coast for sounding rockets. It is finding that it's too expensive to go to Colomb Bechar in North Africa every time it wants to make a shot. . . . Although the U.S. Army ordered Nord *Entac* antitank missiles with the idea that they were already in production, it's reported that the first production-line models won't be available until the end of the year. . . . West Germany expects to spend $400 million on defense procurement in the U.S. this year. In addition to $120 million for *Pershings*, it will be buying *Nike*, *Honest John* and *Sergeant* missiles as well as aircraft.

DOD Defines 'Selling'

The Pentagon for the first time has issued a comprehensive directive on military and civilian standards of conduct including a new, stiffer definition of "selling."

A spokesman for the team of DOD lawyers who wrote the directive said the guidelines stressed the need for as much clarity as possible within the confusing pattern of laws passed over the last century or more. The guidelines also emphasized that the tightest and strictest possible language was to be used.

The directive's key change defines "selling" to mean: "(1) signing a bid; proposal or contract; (2) negotiating a contract; or (3) settling disputes concerning performance of a contract; (4) any other liaison activity within a view toward the ultimate consummation of a sale even though the actual contract therefore is subsequently negotiated by another person. However, it is not the intent of this Directive to preclude a retired officer from accepting employment with private industry solely because his employer is a contractor with the Government."

Shots of the Week . . .

The Navy's advanced *Polaris* whizzed nearly 1600 miles down the Atlantic Missile Range July 14th, raising Navy hopes that the missile may be losing some of its temperament. It was steered by an all-inertial guidance system.

NASA fired three rockets from its Wallops Island facility. Two *Nike-Apache* sounding rockets were set off to determine altitude and intensity of electric currents in the ionosphere. A *Nike-Cajun* carried a 60-lb. payload including 12 grenades which were ejected and detonated at intervals from 23 to 56 miles altitude. All three shots were successful.

Biggest-yet Polaris Sub

The Navy's largest *Polaris*-firing submarine, Ethan Allen, joins the fleet early next month.

She is the first designed to fire the longer-range 1500-mile *Polaris*, has a length of 410 ft., weighs 6900 tons and will have gone from keel-laying to commissioning in less than 23 months. It was General Dynamic's Electric Boat Division.



Mountain Campsite on Moon

IDEAL LUNAR BASE SITE would be in the Mountains of Eternal Light near the moon's north pole, say North American scientists. The area would be in continuous sunlight, advantageous for solar power and plant growth. Dome at left is inflatable plastic. NAA experts are working on long-range lunar base requirements such as extracting necessary elements and compounds from the moon's surface.

Tiros III Aids Mercury

Information from *Tiros III* on Caribbean weather conditions affecting *Mercury* launch is being fed to the Cape. The data is analyzed by PMR or Wallops, sent to the Weather Bureau in Suitland, Md., then flashed to the *Mercury* Project Office in Florida. The satellite is programed for twice-a-day coverage.

Rickover — Abolish AF

Vice Adm. Hyman Rickover has proposed that Congress abolish the Air Force, saying it would probably reduce the cost of national defense.

In testimony before the House Appropriation's Subcommittee, he suggested combining SAC with the Navy and the AF's missiles with Army.

He said: "By returning to two services you will . . . eliminate some of your difficulties; you will be subjected to the same compelling arguments for appropriations from the two instead of three groups."

Free Spacecasting Favored

The U.S. communication satellite system should be open to all nations, including Red China and the USSR, USIA Chief Ed Murrow suggested to the House Space Committee. Said Murrow, "if we could freely transmit to Russia and China and they could freely transmit to us, I have no fear of the outcome."

Murrow also suggested an international space communications year, similar to the recent International

Ion Engine Capsules by RCA

RCA Astro-Electronics Div. has been selected to develop a payload capsule for flight-testing electric propulsion engines.

The program calls for seven capsules, three for ground tests and four for flight testing. First launch is scheduled for the last quarter of 1962 aboard a *Scout* rocket. The capsule will carry one cesium- and one mercury-fueled ion engine.

Flight testing is necessary in proving out feasibility of ion propulsion because the exhaust beam of an ion engine is influenced by the walls of even the largest feasible vacuum tanks.

Geophysical Year, "to prepare for the day when we will need qualified men from Conakry to Calcutta to help operate the satellite system."

Yuri Bypasses U.S.

Russia's peripatetic spaceman-goodwill ambassador, Yuri Gagarin, is due in Havana this week to help Castro's July 26th celebration get off the ground. He'll bypass the U.S. because "I have not received an official invition . . . So how can I go there without being invited?"

Earlier this month, NASA Administrator James E. Webb chided the Russians for sending their cosmonaut on a propaganda tour while not releasing pictures of his orbital flight. Webb said U.S. astronaut Alan Shepard's refusal to take publicity trips was his own decision, but that America may want to send spacemen on tour in the future.

While in England, Gagarin told a press conference his flight into space would "soon be followed by a second, a third and many, many more."

NASA Looks Over MacDill

NASA will send a survey team to MacDill AFB, Tampa, Fla., to check on its possible use as NASA headquarters, should Congress approve an increased appropriation for the space agency. Dr. Hugh Dryden said MacDill was one of the sites under consideration.

Meanwhile, Air Force Chief of Staff Curtis LeMay said that the AF was willing to share its MacDill facilities with NASA or, if NASA wanted to use the entire base, to speed up its phase-out program there.

Boost for Job Fairness

Eight large defense contractors have pledged themselves to a no-job-discrimination plan, approved by the government. The pact, affecting some 800,000 workers, is similar to the one signed some weeks ago between Lockheed and the President's Committee on Equal Employment Opportunity.

President Kennedy said that during the next several months similar agreements will be sought with other large employers with government contracts.

Signing the pledge were the presidents of Western Electric, Boeing, Douglas Aircraft, GE, Martin, North American Aviation, RCA and United Aircraft.

Powerful Radio Telescope

A radar telescope with a parabolic reflector 150 feet in diameter is being constructed under the auspices of Stanford University and the Stanford Research Institute for completion later this year.

Requiring a power supply of one million watts, the new telescope is the most powerful ever built to operate in the 20-60mc. frequency range. When completed the huge dish antenna will enable scientists to obtain more accurate measurements of cosmic distances, surface explorations of the moon and planets, ionization data on the sun and planets and information on interplanetary ionized gases and debris.

The radar telescope will be operated jointly by Stanford University's Radioscience Laboratory and the Research Institute's Communication and Propagation Laboratory, with support from the Air Force's Cambridge Research Laboratories.

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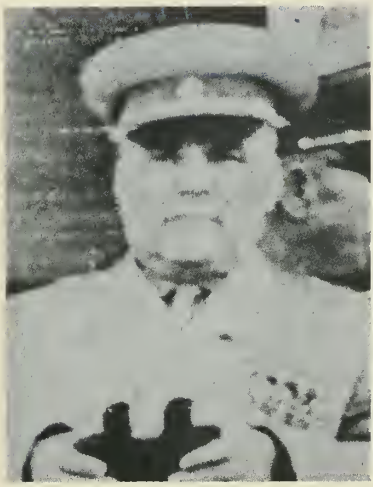
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In Berlin war scare . . .

Build-up of Army Missiles?

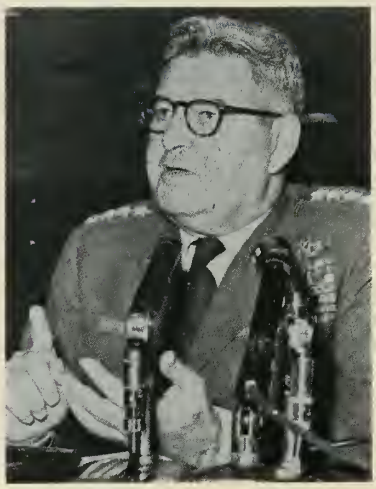
Expected emergency muster of reservists would necessarily call for extra tactical missiles; Soviets have announced increased emphasis on rockets; LeMay seeks more bombers

by James Baar



Malinovsky

". . . all weapons of the Armed Forces are being converted to rocket equipment . . ."



LeMay

"Put your finger on the button and you are at war . . . leave it off and have peace."

THE ADMINISTRATION is expected to call for an emergency increase in the nation's limited war forces including a major boost in the procurement of tactical missiles.

The price tag generally mentioned, as President Kennedy prepared a television report to the nation and a new special budget message to Congress on the Berlin crisis, was $1 billion or more.

Key members of the Senate Appropriations Committee, which has been withholding action on the FY '62 defense appropriations bill to give the Administration time to prepare its new request, made clear that they would readily approve the additional money and probably considerably more. Other members of both the Senate and House made similar supporting statements.

The core of the President's new request—scheduled to be sent to Congress July 26—was expected to be a plan to call up large numbers of reserve troops. Implicit in any such plans is the need for sizeable procurement of modern Army weapons including tactical missiles.

In recent years, the Army's 14 partly understrength divisions have consistently lacked sufficient quantities of modern weapons, from rifles to *Redstones*. There are no large stockpiles merely awaiting distribution.

How much production lines can be expanded or speeded up to meet the coming Berlin crisis this fall was not immediately clear. However, some of the President's comments indicated that he may be looking considerably beyond Berlin. He told a news conference on July 19:

"I am making my judgment on what I consider to be the relative power balance between the Communist bloc and ourselves, the attitude which the Communist bloc is now taking and what possible needs we might have in protecting our commitments . . . We operate at the end of a long supply line and others in some cases operate at the end of a short supply line . . . We have commitments in Southeast Asia, we have commitments in Berlin, and we are being very vigorously challenged."

At another point he added: "We have to look forward to many challenges in the coming months and years."

• **The line-ups**—An understanding of this challenge can be gained by comparing the current strength of NATO and Soviet Bloc forces in the heart of Europe.

The Red Army is reported to have 22 divisions in East Germany. Six are armored, six mechanized infantry, 10 conventional infantry. The East Germans have seven more divisions. The Czechs have eight.

Confronting these forces on the other side of the Iron Curtain in West Germany are five U.S. divisions, 12 West German divisions, seven British brigades, one French division and a number of other U.S. units including three crack armored cavalry regiments. Even this force is smaller than it looks because five of the West German divisions are still building toward full strength.

Moreover, the imbalance grows as you move away from the heart of Europe. Behind the NATO forces are four Italian divisions in Italy and a few units elsewhere in Western Europe. Behind the Communist forces are 150 Red Army divisions, the majority of which are at full strength.

Sixty of the Red Army divisions are armored. The Russians have been producing tanks at the rate of about 5000 a year.

• **Red rockets grow**—Recently, the Russians have sought to make this imbalance on the ground even greater by placing much heavier emphasis on their rocket and nuclear forces. In a recent little-noted speech, Soviet Defense Minister Rodion Malinovsky announced the reorganization of Soviet Armed Forces around rocket-bearing units and independently-operating nuclear groups.

"It is a most important fact," he said, "that all weapons of the Armed

Forces are being converted to rocket equipment. Thus the rocket units and formations are becoming the basic fighting strength of all branches of the Armed Forces."

"The (Communist) party and Government have taken all measures to insure the growth of the striking and fire power of the Armed Forces," he declared.

Marshal Malinovsky also made clear that he expected any future war to invoke the use of nuclear weapons.

Significantly, the Marshal's speech was delivered at the same time that Soviet Premier Khrushchev was announcing a 3-billion-ruble increase in the Soviet defense budget. Some Soviet experts have estimated that this could mean an actual total increased Soviet defense spending of $12 to $15 billion (M/R, July 17). Others have estimated that the Russians may be increasing their defense spending by 68% in the next six months alone.

Deputy Defense Secretary Roswell Gilpatric insisted earlier this month that the Pentagon's latest review of the nation's defenses was "directed primarily at the preparedness measures which could be taken in the near future—in a matter of months—looking toward strengthening the posture of our conventional forces."

However, the calling up of reserves and the long-delayed increase of procurement of modern weapons for the Army could have a far-reaching effect on the overall strength of the nation's defenses. Also, there is mounting pressure in some sections of Congress for new overall increases, particularly involving bombers.

• **Missiles plus**—Gen. Curtis LeMay, Air Force Chief of Staff, renewed the Air Force plea in testimony before the Senate Defense Appropriations Subcommittee for $448 million for full development of the B-70 Mach 3 bomber instead of the $220 million bob-tailed program requested by the Administration.

LeMay also gave his personal nod to the $525 million that Congress seeks to press on the Administration to keep B-52 missile bombers in production.

"We want the missiles," LeMay growled, "but we must have a mixture of manned and unmanned systems for proper defense.

"If you have only missiles you have no flexibility. You put your finger on the button and you are at war, or leave it off the button and you have peace. You cannot threaten or make known your intentions to fight over an issue."

All indications were that Congress agreed with LeMay. By the end of the week, there were some signs that the Administration might be reaching the point where it might, too. ⌗

NASA Adds to Weight Of Apollo Lunar Spacecraft

NASA DISCLOSED three important facts about the *Apollo* Man-to-the-Moon Program last week at a secret NASA-Industry Technical Conference:

—The *Apollo* spacecraft despite its ballistic shape will have to weigh about 20,000 to 25,000 pounds rather than the 15,000 to 20,000 previously anticipated.

—There appear to be no insurmountable technical obstacles to landing a manned spacecraft on the moon and returning it to earth.

—NASA still does not have a firm *Apollo* program in mind nor has any decision apparently been made as to the precise way that NASA will manage the multibillion-dollar drive for the moon.

Essentially NASA presented to the hundreds of Missile/Space Industry representatives who attended the closed-door three-day session a comprehensive look at the technical problems and potential solutions of the *Apollo* program as seen so far. However, there was no discussion of such matters as firm plans, schedules, costs or managerial organization.

The reaction was mixed.

Many representatives from firms on the fringes of the *Apollo* program found the sessions highly enlightening. But representatives more familiar with the program found little new. There also were complaints that the 32 papers which were read and which will be available later might just as well have been mailed in the first place.

As one engineer put it: "How much would the program have been advanced if the cost of bringing everyone here had been spent on it?"

• **The outlines**—The broad, tentative plan for the program as it was pieced together from the technical papers calls for a ballistic-shaped, 20,000-to-25,000-pound command spacecraft capable of manuevering sufficiently to make an earth-landing on the ground—not water as previously thought.

The spacecraft will have an L/D ratio of about .5. It may have flaps. It also may have one of a variety of landing devices that would have an L/D ratio of 4 to 6.

For the lunar-landing mission, the *Apollo* spacecraft may have to rendezvous in orbit with propulsion and other units. This will be a must if the *Saturn C-3* is used. However, it is still much too early for a determination of booster systems.

The NASA papers on the configuration of the spacecraft were based on the three now-completed studies made by Convair, GE and Martin as well as a fourth study made by NASA itself. The four configurations are generally similar.

However, NASA has consistently stressed that the three industry studies and its own will not prejudice the coming award of R&D contracts for the *Apollo* spacecraft.

Although nothing was formally said at the conference about the award of these contracts, reports persist that a bidders conference probably will be held sometime next month and that contract awards will be made about the first of the year.

• **Manning the helm**—One problem that could delay awarding contracts is managerial rather than technical. So far, NASA has not made clear precisely how it plans to run the *Apollo* program beyond the idea of appointing a super manager and staff within the agency's headquarters. NASA currently is looking for a man to fill the super manager job (M/R, July 17).

One of the managerial questions to be settled is whether NASA or some outside contractor will provide overall technical supervision of the diverse elements of the program.

NASA Administrator James Webb spoke at the *Apollo* Conference in only the broadest terms of working together and selling the *Apollo* program to the public as a team. However, at one point, he said that about 15% of the *Apollo* budget would be spent within NASA, the other 85% with outside contractors.

Even as he talked, the huge Man-to-the-Moon program cleared another hurdle in Congress. House-Senate conferees approved the re-revised $1.7 billion NASA authorization bill for FY '62.

The conferees made no change in the total amount in the bill, but they switched $10 million from construction funds to R&D on solid propulsion and electrical propulsion systems. The more-than-half-billion dollars for *Apollo* emerged untouched. ⌗

Replacement for U-2 . . .

Samos May Eye USSR for Up to 1 Year

Air Force adds new unit and extra technicians to handle flood of photos; details of improvements in the system

by Frank G. McGuire

THE THIRD R&D *Samos* reconnaissance satellite is expected to scan Russia for up to a full year—yielding a deluge of photo data.

Launch of *Samos III* carrying a new long-life solar power system is due this week. It will be fired into polar orbit from Point Arguello, Calif.

In preparation for the shot—part of a stepped-up effort to get an intelligence replacement for the grounded U-2 operational as soon as possible—the Air Force has established a *Samos* data processing unit at Strategic Air Command headquarters, Offutt AFB, Neb. It also has increased the number of technicians in the photo analysis unit of its Satellite Test Center (STC) in Sunnyvale, Calif., to between 30 and 50.

The increase in manpower at the STC photo analysis unit, part of the 6594th Test Wing (Satellite), presages a great increase of raw data into the center and the group will go on a three-shift-per-day basis when the input begins.

The similar but smaller group at SAC headquarters will assist in target planning and other activities. Primary center for all data processing during the R&D phases of the program, however, will be at the STC.

Processing of the film itself is done by a highly automated system consisting of a number of stations. Known as "interrupted processing," the method involves development of the film only to a minimum extent, whereupon the partly-developed image is electronically scanned to determine the steps needed to get the utmost from the film. The scanner transmits information about the image into a computer which determines the remaining processing. Time of additional development, temperatures, solutions and other information is calculated, is programed automatically.

• **TV readout**—By this means, the absolute maximum potential of the film is realized, and USAF obtains optimum benefit from the satellite's capability.

A contract estimated at $20-$25 million between the Air Force and Thompson Ramo Wooldridge reportedly was curtailed last November for unexplained reasons. The contract was for a complete data processing system for *Samos* and was let by AF's Data Systems Project Office. The computer-operated setup was said to be "too specialized" for its application. There is no indication as to the Air Force's planned substitute for this equipment.

A television readout system will be used in the initial phases of the program, but later satellites may use both TV and recoverable-capsule techniques to return data to the ground stations. Presently, some data quality is lost due to propagation, and the criticality of the loss is dependent on the nature of the information. Losses in telemetry readings of pressure points, radio frequencies, or other electromagnetic radiation are a little less critical than actual photo data.



SATELLITE FLIGHT is monitored by Air Force and civilians at headquarters of 6594th Satellite Test Wing.

Ground commands are first used to turn the *Samos* cameras on as the payload passes over selected points on the globe, then to turn the equipment off in order to conserve power. Presently, magnetic tape storage is utilized to maintain data in the payload until readout is accomplished upon command of a ground station. These ground tracking and command stations include those at Kodiak, Alaska, New Boston, N.H., and Vandenberg AFB, Calif. In addition the station at Kaena Point, Hawaii, will support operations.

At the optimum point in the orbit, VHF antennas will extract stored data from the payload, re-record it on tape, which will then be flown to Moffett Field, near Sunnyvale, for transfer to STC. The VHF TLM-18 multi-channel FM/FM transmitter in the satellite verifies command functions, reads out critical vehicle functions and handles payload equipment data. A separate system is believed used for detailed photographic data.

Supplementally to the telemetry data transfer method, the Air Force expects to recover film capsules from some of the satellites. This would eliminate transmission losses and provide verification of marginal information.

Speculation on resolution of the photographic equipment credits the system with being able to identify a 10-ft.-diameter object from 300 miles altitude.

Another recent improvement was the doubling of STC's computer for *Samos* orbital cal-



REMOTE STATION at Kodiak Island, Alaska, is part of far-flung tracking and telemetry net for Samos, Discoverer and Midas.

culations from 8000 to 16,000 48-bit words.

• **Solar power system**—A major improvement in the operating life span of the *Samos* vehicles has been the inclusion of solar power units to lengthen the estimated three week life span of *Samos II* to at least six months and perhaps a year for future payloads. Orbital altitude of the vehicles will determine this to a large extent, since radiation could cut the solar cells life significantly.

The system was first checked out partially on *Midas II*, which had three sections of silicon cells, comprising 26 square feet, secured to the aft end of the *Agena B* vehicle. The test system may also have been used on *Samos II*. Output was about fifteen watts for the three fixed collectors. Performance of the test system was used to aid in design of movable, larger solar collection arrays for the operational vehicles.

The test system operated well over 5000 hours without noticeable degradation of the cell performance. The vehicle's commutator stopped functioning, but the ¾-watt transmitter continued blocking the assigned frequencies. The solar power system was never used on an *Agena A*.

Midas III, launched July 12 from Vandenberg AFB, was the first to use the large double-array system designed to track the sun. This satellite weighed 1500 lbs. less than its two predecessors, presumably because a large portion of battery weight was eliminated, along with other equipment.

The larger solar power system is designed to provide 300-500 watts average power to the payloads of both *Midas* and *Samos* vehicles, with a heat power of about one kw on the array. Minimum specified performance on the silicon cells is 8.8% operating efficiency, but the panels do better than this. Power output is approximately 6.6 watts per square foot, and the payload is designed to operate effectively on half the available power, in event of failure.

Although average power is 300-500 watts, superimposed peaks of over one kilowatt are expected.

• **Coating problem**—A number of protective material coverings for the arrays were tested, with the aim of reducing micrometeorite and other particle damage, reducing input of thermal radiation which would cut array efficiency, and allowing transmission of a maximum amount of useful solar energy. Arrays are covered with a six-mil layer of glass, and weight of the assembly is about 1.1 lb. per sq. ft.

Excessive damage by radiation in the environment of space may force a switch to the radiation-resistant N-P cells and heavier glass, instead of the present P-N cells with the lightweight glass.

Due to stabilization of the vehicle, relative to the earth's horizon, an ideal reference plane is established for the solar array's sun-tracking system. This equipment was located at the rear of the *Agena B* vehicle, while the payload is located in the nose. The orbital configuration is thus established as a "T," with the nose-down satellite extending its two solar collector arrays parallel to the earth's surface.

The collector array system is housed at the rear of the vehicle in a folded manner, and extended by stepper motors at the desired time. The degree to which the extension takes place is dependent upon the power requirement of the vehicle payload. Maximum extension is approximately eighteen feet, while the array is about five feet wide.

Each array has 36 sections, 14 in. x 17 in., providing power to a regulator, which governs recharging of nickel-cadmium secondary batteries. The individual sections contain 740 separate 1 x 2 cm. silicon cells, arranged in ten-cell modules and connected in parallel on Kovar strips to make up a single-array 28-volt collector element.

The design gives the thinnest mechanical structure possible, in order to allow large-area arrays and adequate heat conduction through the panel.

• **Tracking control of array**—A dual stepping-motor drive is used to move the array while sun-tracking is in progress, and operates through a differential gear assembly. The two stepper-motors, when rotating in opposite directions, move the array about its own axis, while rotation of the two motors in the same direction move the array about the vehicle axis.

Conventional sun-seeking sensors are utilized for tracking, and seasonal adjustments are made by ground command. ⁂

Cape Due for $65 Million New Construction This Year

CAPE CANAVERAL—The Corps of Engineers is getting ready to let a contract for building a second *Saturn* launch complex—bringing to about $65 million new construction planned at the Cape for the remainder of the year.

The *Saturn* contract—estimated at $10 million—is expected to run to $17 million by the time the complex is fully instrumented. Other major projects:

—A second *Centaur* launch complex, estimated at $16 million.

—Conversion of a *Titan* pad by The Martin Co. to handle *Dyna-Soar*, estimated at $16 million.

—Various new facilities at Patrick AFB costing a total of $2.1 million.

—A *Polaris* checkout building, $1.8 million.

Another $5 million will be spent on a new ocean cable installation between Puerto Rico and Antigua, and $3.4 million for tracking facilities on Grand Bahama Island and Puerto Rico.

The new *Saturn* service tower will be 300 ft. tall, 10 ft. shorter than the first, but will have a bigger base. ⁂

Shortcut studied . . .

Prospect Of Orbital Shot in 1961 Is Fading

by Hal Taylor



ASTRONAUT VIRGIL GRISSOM . . . he had to wait.

CAPE CANAVERAL—Chances of an American orbiting the globe this year are growing more remote. The flight is now almost certain to slip into 1962.

NASA officials here for the second *Mercury Redstone* ballistic shot are conceding that only a string of spectacular successes with *Mercury Atlases* could make a manned orbital spaceflight possible before Jan. 1.

The main reason: *Mercury Atlas* is slipping badly. The launching of *MA-4* —scheduled to go in mid-July—has now been put off until early September.

This became known during last week's preparations for Air Force Capt. Virgil I. Grissom's programed 287-mile flight with a 116-mile apogee aboard a *Redstone*. Scheduled originally for July 18, the flight was scrubbed that day and again on July 19 by bad weather. It was rescheduled for July 21.

Grissom spent 3½ hours in the capsule aboard the fueled missile on the 19th, waiting for a "window" in the cloudy skies. The launching was postponed on the previous day before the countdown reached the fueling time. Once the *Redstone* is fueled there is an automatic 48-hr. recycling period for de-fueling and drying the LOX tanks.

• **Risky shortcut**—Another reason for slippage in the *Mercury Atlas* orbital program is a NASA regulation requiring manned space vehicles to undergo a minimum of six weeks of pre-flight checking on the pad.

NASA officials are presently considering a calculated risk which could speed up the program. This involves scratching the second launch in the orbital schedule—*MA-5*—which would orbit a monkey three times around the earth. Instead, the *MA-6* manned orbital flight would follow shortly after the successful launch of *MA-4*.

This could move the time schedule for *MA-6* up to November or December. However, seasoned observers see such a move as only a remote possibility. Besides regarding it as a questionable technical approach, the space agency apparently is not ready to risk U.S. prestige on a program that has not been adequately tested.

There is one slim chance for culmination of Project *Mercury* in 1961. If *MA-4, 5,* and *6* are completely successful, space agency officials contend, it would then be possible for the U.S. to duplicate this year the April 12 flight of Soviet Air Force Maj. Yuri Gagarin.

"If we get hot with *MA-4*," said one top official, "an optimist might believe that we would make it by Christmas."

• **No backups**—Working against such a possibility, however, are these hard facts:

As of now there are no backup missiles available for the *Mercury* program. Six *Atlases* are at Cape Canaveral. One will be used for the *Ranger* lunar probe slated for July 28. Three are *Atlas E*-model ICBM's which will be launched in R&D shots. Another is for a *Centaur* missile which will be fired as part of its development program.

The last will be used by Project *Mercury* as a booster for *MA-4* and will be placed on its launch pad sometime this week.

The boosters for *MA-5* and *MA-6* are not in sight at the moment. Thus, if any of the *Mercury Atlases* should blow up, it would delay the whole program for at least one month.

There is only one *Atlas* pad equipped for *Mercury* launchings. Lengthy delays would result if it were extensively damaged in a booster malfunction. Even when a launch is successful, it takes about a week to clean up the pad before another booster can be placed on it.

The reliability of the *Atlas* itself is still a question, although top officials of NASA's Space Task Group state flatly that they have complete confidence in the big booster.

It is a matter of record, however, that two out of three *Mercury Atlas-D* launchings have been failures. *MA-1* failed in September, 1959, because of a weakness in the stop structure caused in mating the capsule. This problem was corrected in *MA-2*, launched successfully in a downrange ballistic flight in November, 1960.

MA-3, lifted from its pad in April 1, 1961, only to be destroyed by the range officer when a programer malfunctioned, sending the booster straight up into the air. Many *Atlases* have been launched in Air Force development programs and none ever developed the same autopilot weakness. Space agency officials feel that it is unlikely that it will happen again.

Critics have charged that NASA should have scheduled more firings of the *Atlas-D* model to certify its reliability. Government officials point out, however, that under the Eisenhower Administration—when the *Mercury* program began—not enough money was made available for purchases of needed *Atlases*. The big booster has to be ordered from its manufacturer, Convair Division of General Dynamics Corp., from 18 months to two years before delivery.

If the Grissom flight is successful, the *Mercury Redstone* shots probably will be discontinued. This might mean that Grissom's backup—40-year-old Marine Lt. Col. John H. Glenn—will be picked for the first orbital shot. ⁂

More Work for Hard-hit Small Firms

by James Trainor

DETROIT—Military leaders are promising to pass out a much larger share of DOD contracts to small business in depressed areas.

The new policy will extend beyond just urging prime contractors to subcontract out more of their work.

Brig. Gen. Fred Thorlin, commander of the Army's Ordnance Tank-Automotive Command, told the third annual Michigan Aeronautics and Space Association conference last week a plan being instituted by the Army calls for:

—Procurement arbitrarily set aside for small business participation.

—Early breakout of those components which it is felt that small firms can produce.

—A greater effort to obtain drawings and specifications of "sole-source" items so that these items can be competitively procured from other firms. especially small business.

—Encouragement of large manufacturers to sub-contract with small companies.

—More emphasis placed on advance publicity of proposed procurements, especially contracts appropriate to small business. (In this regard, Thorlin urged prime contractors to use the Department of Commerce Synopsis—free of charge—to advertise for sub-contractors.)

Thorlin said the Army has a goal of increasing awards to small business by 10% in FY '62 over what was awarded in FY '60, and that the Army intended to meet that goal. Navy and Air Force officials also urged industry representatives at the conference to solicit more business from small firms.

• **Military Space**—Gen. Bernard A. Schriever, commander of the Air Force Systems Command, reiterated pleas for a greater military space role. To meet the challenges of space, Schriever said, two things are essential: full national awareness of the implications of space and more efficient program management. New organizations and new techniques are needed to replace the outmoded techniques of mass production.

The general hung up six goals that must be achieved in this decade:

—Large payloads orbited by 1965.

—A space navigation and maneuver capability.

—De-orbiting and landing of spacecraft.

—Capability to transport, support and utilize man in space.

—Rendezvous in space.

—Construction of manned and unmanned space stations.

Schriever's thesis of military space got an unexpected boost when NASA's Wernher von Braun told a banquet audience that "space superiority has replaced air superiority out there."

• **Industry speaks out**—During the four panel discussions on procurement planning of each of the three military services and NASA, industry leaders pointed out some of the deficiencies in procurement policies of the government.

The Navy received the first broadside when Dan Kimball of Aerojet questioned the wisdom of the constant rotation of officers in and out of Washington. Lockheed's Stanley Burris argued that, rather than giving industry detailed requirements for what the Navy thinks it needs, it should require industry to maintain high standards of quality and reliability. Burris said the Navy should apply the Soviet formula of "selective technology" to future planning to formulate procurement plans with industry and scientists for 10 years into the future.

B. M. Brown of Westinghouse voiced the sentiment that not only should a DOD contractor be able to earn additional profit from a job well-done, but a firm should be able to lose money for inefficiency as well.

Walter G. Bain of RCA outlined a program for future space agency contractual actions:

—Let industry know the future objectives of NASA.

—Give companies prompt authority to proceed after a contract award.

—Adequately fund those projects that are approved.

—After a contract is let, debrief companies so that they will know the deficiencies of their proposal.

—Give industry a chance to compete for additional profits.

—Pay more than lip-service to fixed price and incentive contracts. Contracts that the government expects a company to take for the prestige involved, are hard to justify to the stockholder when he opens his dividend envelope. ⁂

New Look in Kiwi Reactors: Near-Flyable

SCALE MODEL of *Kiwi-B* nuclear reactor testbed for nuclear rocket shows closer attention to rocket-type exhaust nozzle, reactor pressure vessel reduced by about one-third over *Kiwi-A* series, and simplified ducting.

First hot run of the liquid-hydrogen-fueled engine is expected this fall, and although calculations and simulation indicate no difficulties with use of gaseous hydrogen, Los Alamos Scientific Laboratory spokesmen say the test should be "an interesting experiment." The reactor in *Kiwi-B* is a close approximation of a flyable reactor, and is now being assembled at Project *Rover* test area at the Atomic Energy Commission's Nevada Test Site.

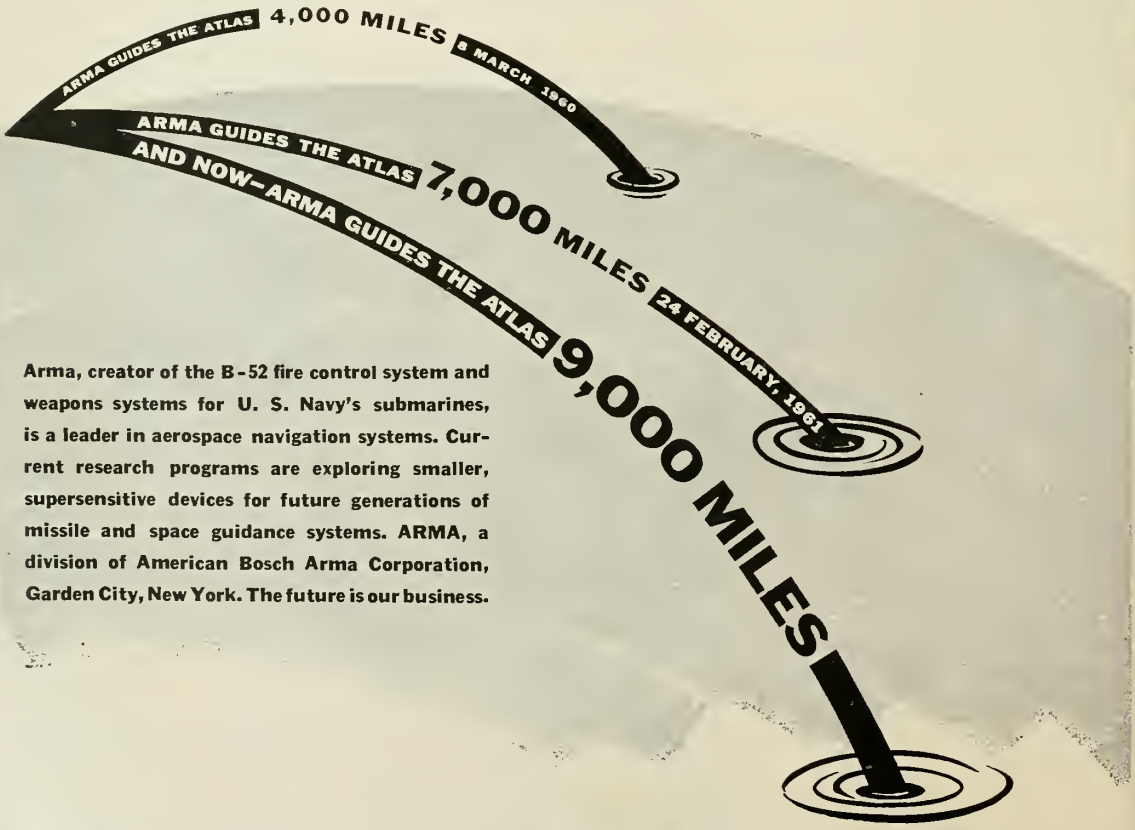


ARMA guides Air Force ATLAS in first full-range inertial flight

Cape Canaveral July 7, 1961. The Air Force announced the successful flight of an Atlas ICBM guided by the Arma inertial system 9,000 miles into the Indian Ocean.

A giant step in missile and space technology, this important feat of pin-pointing a target nearly half-way around the world demonstrated the phenomenal accuracy and reliability of Arma inertial guidance—America's first inertial guidance system of intercontinental range accuracy. This flight was another achievement of Arma inertial guidance which has performed successfully on every flight since the initial test in March 1960. Today the Arma system is in full production.

Arma inertial guidance provides our nation's ICBM arsenal with all the advantages inherent in inertial guidance—salvo firing, all-weather capability, immunity to outside interference, a minimum of costly ground equipment. Although specified for the Atlas missile, the Arma inertial system as a completely self-contained, self-correcting navigation system is adaptable to other aerospace programs and space exploration projects.



Arma, creator of the B-52 fire control system and weapons systems for U. S. Navy's submarines, is a leader in aerospace navigation systems. Current research programs are exploring smaller, supersensitive devices for future generations of missile and space guidance systems. ARMA, a division of American Bosch Arma Corporation, Garden City, New York. The future is our business.

AMERICAN BOSCH ARMA CORPORATION

Technical Countdown

SUPPORT EQUIPMENT

Midas/Discoverer Tester Contract Awarded

RCA has just won a contract to supply operational simulation systems to test future *Discoverer* and *Midas* satellites. The award of more than $500,000 was made by Lockheed to RCA's Aerospace and Controls Division, for its Automatic Programer and Test System. This is believed to be the first system designed for automatic exercising of a major satellite's electronic subsystems in a space environment over a long time period.

Crystal-balling by Radar/Optics Studied

A study conducted by Armour Research Foundation for the Army Signal Corps indicates that meteorological profiles can be obtained up to 5000 feet by using a computer and radar and optical radiometers. A microwave radiometer—measuring oxygen emission in the 60-gigacycle region, and an infrared radiometer—measuring the emission from carbon dioxide in the 4.3-micron region, would feed their readings into a computer where the data would be converted into temperature-height profiles.

ASTRONAUTICS

UK Observatory Ready Soon

The new radio astronomy observatory at Defford, England, will soon be operational. Built for the Royal Radar Establishment by Woorkspoor N.V., Netherlands, the station will employ twin 82-ft. dishes. The 250-ton structures can be operated independently or dually to form an interferometer. In the latter mode, the system will permit very high angular discrimination. Operating in the 30-3000 mc range, the observatory will be used primarily for upper atmosphere and space research. A secondary effort will be made to study the causes of false radar echoes in missile early warning radars. Installation cost is expected to exceed £350,000.

British Instrument Launch Due by '62

Preparatory to launches by U.S. space vehicles later this year and next, the British will test-fly satellite instrumentation in their *Skylark* rocket at the Woomera Range in Australia. The instrumentation for the first satellite is designed to measure electrical charges in the ionosphere and cosmic ray particles. The second instrument package includes measurement of ozone concentrations, waves from electrons and micrometeorites bombarding the atmosphere.

U. of California Gets New Radio Telescope

A comparatively small, versatile radio telescope has been installed at the University of California as a gift from the Office of Naval Research. The 10-ft. dish is capable of intercepting much shorter wavelengths (4-8 mm) than those received by larger operational radio telescopes. The antenna —with a beam width of between one and two tenths of a degree—will be used to study such things as variations of solar activity on the sun, sunspots, solar flares, polarization of solar radiation, lunar radiation levels and planetary surface temperatures and chemical atmospheric compositions.

ASW AND SEABORNE SYSTEMS

Artemis Tackles Problem of Surveillance

Artemis—the Navy's program to determine the feasibility of very long-range undersea surveillance—has taken a step forward with the addition of a powerful sonar transducer and "advanced signal processing equipment" aboard the USS Mission Capistrano. The gigantic transducer—weighing hundreds of tons and consuming enough electricity for a town of 50,000—can be lowered into the sea for data gathering and recovered. A sister installation at Argus Island—30 miles southwest of Bermuda—is used in connection with hydrophones that relay sonar echoes to high-gain receivers.

New Sub Depth Gage Developed

A 3-5 times increase in measuring accuracy has been achieved with a new submarine depth gage developed by Westinghouse, the company reports. Capable of operating at depths five times greater than ever before, the new gage employs electrical measurement rather than mechanical (Bourdon tube) measurement used in conventional gages. Readout is by numerical meter instead of indicator dial.

MATERIALS

High-Flux Research Reactor Designed for NBS

A reactor to study basic structural properties of matter has been designed for the National Bureau of Standards' new Gaithersburg, Md., site. The high-flux device will be used to analyze atomic and molecular structure by neutron diffraction. In addition to its use in studies of crystal structure, intermolecular force constants and chemical bond strength, this powerful tool will have practical advantages in investigations of radiation processing and radiation effects on structural materials.

Space Flight Repair Pack

Engineers at Chance Vought and the Air Force's Aeronautical Systems Division are studying the problems of maintenance work in 3-D space under a $58,500 contract. A model of "back pack" is expected by next year. The study will determine how the pack can be used to give a weightless man control of his body while he makes repairs to operational space vehicles and satellites.

Dried Out Transistor Production

Precise moisture control techniques are resulting in power transistors with 3 to 4 db increased power gain and substantially reduced low-voltage saturation on several of Motorola's production lines. The ambient control system uses $BaO + CaSO_4 \cdot \frac{1}{2} H_2O$. Research is extending into germanium mesa transistors with equally good results.

Super Sniffer Developed

Westinghouse scientists have developed EGAD, an electronegative gas detector, which detects and measures gas concentrations as low as 1 part in 10 million. The device is currently being used to check out SF_6 leakage in high-voltage electrical apparatus, where the gas acts as an arc quencher. The unit possesses a 0.33-cu.-in. thermoelectric refrigerator which handles excess water vapor in the gas samples.

Isolation by Elastomeric Suspension

Atlas, Titan, Centaur are among programs whose inertial systems are protected from shock, vibration and noise by Lord-developed suspensions; a report on their advantages

by R. P. Thorn

Supervisor, Electronics Group
Product Engineering Department, Lord
Manufacturing Co., Erie, Pa.

ELASTOMERIC SUSPENSION is solving the problems of shock and vibration in advanced ICBM guidance systems.

Accuracy of both gimballed stabilized inertial platforms and strap-down inertial systems depends to a great degree on their ability to withstand mechanical disturbances.

Each is subject to unwanted responses of vibration, shock, and noise. The kind of isolation or suspension needed varies with the type of system. A highly specialized field, vibration control must be engineered into guidance system design during initial development.

Lord Manufacturing Company believes resilient or elastomeric suspension is superior to hard-mounting sensitive inertial elements because elastic characteristics at attaching points can be controlled with significantly greater precision.

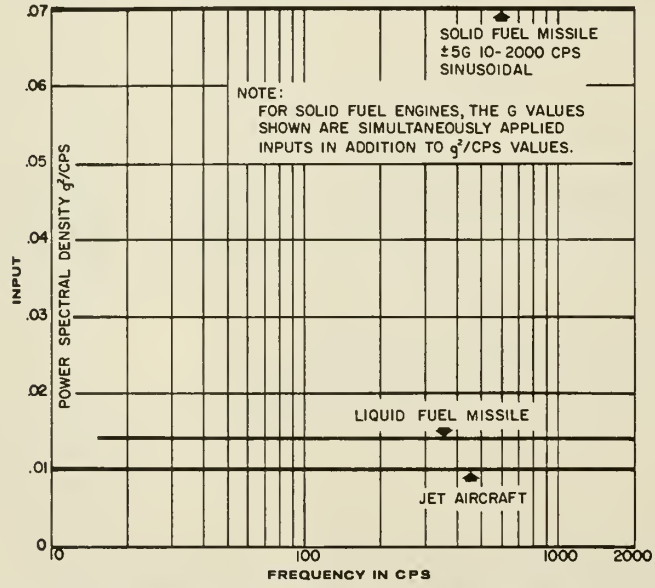
• **Types of systems**—Inertial guidance systems may be divided into two basic types: (1) inertial or gimballed stable platforms and (2) body-mounted or strapdown systems. The function performed is the same for either type.

These systems are designed to guide a vehicle to its destination through a special form of dead reckoning which is independent of ground facilities. The starting point, desired flight trajectory and finish point are programed into the system's computer.

During flight, sensors in the system measure the dynamics of the vehicle, and feed this information to the computer. The computer then evolves displacement velocity and acceleration data which pinpoints vehicle position at any instant in time and space with respect to an accurately known starting point. This position is compared with the desired position, any error is sensed, and the computer signals the vehicle control system to make the correction.

Essentially, the inertial system incorporates two mechanical devices—the accelerometer group and the gyro system—which enable it to provide the navigation computer with accurate flight information. Within the accelerometer group, an accelerometer is aligned to receive dynamic inputs along each of three mutually perpendicular axes. The measured accelerations are doubly inte-

Typical Test Requirements



Characteristic Environments for Aerospace Craft

ENGINE VIBRATION	JET	LIQUID FUEL MISSILE	SOLID FUEL MISSILE
	PURE RANDOM EXCITATIONS		RANDOM WITH SUPERIMPOSED SINUSOIDAL EXCITATIONS
ACCELERATION	0-9 G	0-25G	0-25G
SHOCK	MIL-E-005272B PROC II	15-100 G 5-11 MSEC.	40-100G 1-11 MSEC.
NOISE LEVEL	140db-160db	180db-200db	180db-200db
TEMPERATURE	MIL-E-005272B PROC. I	-100° TO 300°F	-100° TO 500°F
NON-DYNAMIC	MIL-E-005272B PROC. I	MIL-E-005272B PROC. I	MIL-E-005272B PROC. I

Fig. 1—*Comparison of test requirements and characteristic environments typically experienced by missiles and jet aircraft.*

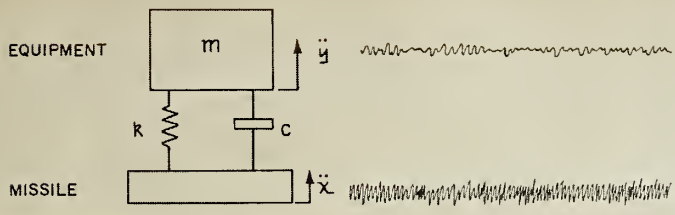


Fig. 2—*Typical trace showing effects of an elastomeric suspension system on random excitation. Random disturbances are effectively reduced between the vehicle and suspended equipment. Only a varying amplitude, narrow band of frequencies near the isolator resonant frequency is felt by the equipment.*

grated by the computer to arrive at the necessary displacement information.

In the stabilized platform, accelerometers are held in their original angular orientation by a three- or four-gimbal, servo-driven stable platform with three gyros. This provides instantaneous acceleration data along the three orthogonal axes of the original orientation.

Strapped down to the vehicle, the gyro system yields the necessary information concerning vehicle motion in inertial space. It merely acts as a transducer and, together with the strapped-down accelerometer group, is subjected to severe shock, vibration and acceleration environments.

Although the mechanical combinations used in both types of inertial navigators are simple in concept, they are exquisitely engineered and produced under ultra-sanitary controlled conditions. But since they are mechanical elements, they have natural frequencies and response characteristics that are functions of mass, spring rate and damping values for the distributed system.

The need for engineered protection is present wherever vibration, shock or noise produce unwanted responses. Accuracy depends, to a great extent, upon the ability of the inertial system to withstand mechanical disturbances. The kind of protection required will vary with the type of inertial system.

• **Low-frequency suspensions**—The stabilized inertial platform system—one which maintains a constant position in inertial space with respect to the starting point, but whose position may change with respect to the vehicular frame—usually requires a low-frequency suspension system because of its physical makeup.

The platform with its stabilizing system is large and massive. As a result, low structural frequencies are involved. The protective suspension must provide isolation efficiency compatible with the low-frequency response characteristics of the whole mass. (High-frequency control capabilities of the suspension are important in protecting individual components, such as accelerometers, which have extremely high resonant amplification.)

In addition this type of inertial navigator is fragile—again requiring a soft suspension for adequate protection. This suspension also must provide enough linear motion to accommodate both the vibratory disturbance and the sustained acceleration.

• **High-frequency suspensions**—The strapdown principle of inertial guidance, now emerging as a practical possibility as problems of computer size are overcome, presents a mounting problem entirely different from the stabilized platform problem.

The strapdown system has many of the same components as the inertial platform. Accelerations, however, are measured with respect to the vehicular coordinates—the three mutually perpendicular axes of the vehicle—and the whole vehicle is related back to the initial reference through a chain of mathematical calculations performed by a highly complex computer. The system must, of course, remain in a constant position with respect to the airframe.

Thus the suspension must provide a connection between the system and airframe that will protect the components, yet be stiff enough to prevent excess motion which could cause malfunction of the control system. This implies use of a center-of-gravity, high-frequency suspension.

Also, the portion of the strapdown system which corresponds to a stabilized inertial platform is smaller and less massive, hence more rugged, than the stabilized system. Therefore, higher frequencies are involved and a stiff suspension system may be used.

• **Range of disturbances**—Severe vibration, noise and sustained accelerations are the types of disturbances which combine to produce various dynamic environments for inertial reference systems.

When the art was young, specifications considered only sinusoidal vibratory disturbances and sustained accelerations. As more instrumentation data became available, it was found that random disturbances were more characteristic of the excitation produced by turbojet and liquid-fuel missile engines. This is an acoustical excitation which is transmitted through the structure and into the control compartment.

Solid-fuel engines introduce another component of excitation: a sinusoidal

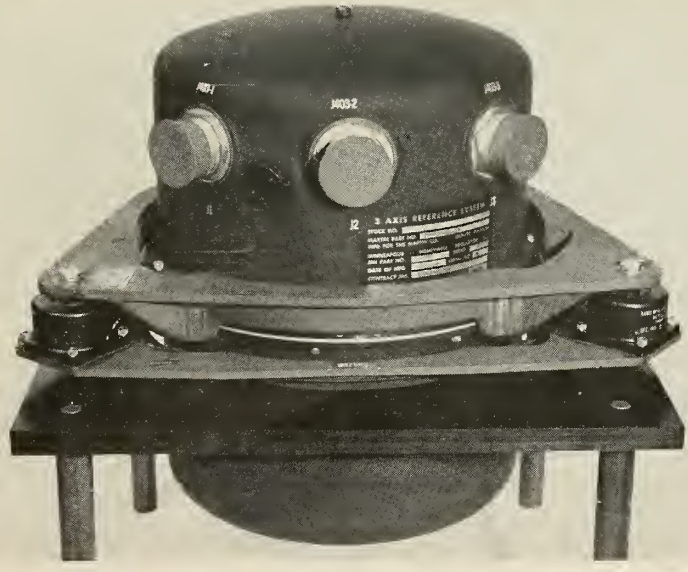


Fig. 3—*Three-point elastomeric suspension system solved degrading high-amplitude vibration problems experienced in Titan I 3-axis reference system.*

acoustical disturbance caused by resonant burning of the fuel in the cavity. It has a discrete frequency and is superimposed on the random excitation. These acoustical excitations will manifest themselves finally as structure-borne disturbances in the control compartment of the vehicle.

Thus there are two characteristic dynamic environments to be considered from an operational standpoint: (1) random, and (2) random plus superimposed sinusoidal. In each case, the equivalent sinusoidal disturbance required to duplicate damage resulting from random excitation may be substituted for test purposes. Superimposed sustained accelerations ranging from a fraction of one g up to 25 g must also be considered. (Typical test requirements and characteristic environments are shown in Fig. 1.)

• **Methods of protection**—Three techniques present themselves as possibilities for protecting an inertial guidance system.

First, the unit can be ruggedized, or made less responsive. This usually results in a weight increase which may degrade the overall performance of the vehicle.

Next, it may be possible to move the response characteristics of the unit out of the region of excitation. This is unlikely, however, in a missile or even a jet application, since it is difficult to build any mechanical structure with a natural frequency over 500 cps (a nominal frequency for this type of application). These excitations may range as high as 5000 cps.

The third alternative—flexible suspension of the unit—provides a method for avoiding degradation of performance while solving the protection problem. Such systems, using elastomeric mountings as flexible protective elements, have been proved successful on the *Atlas* and *Titan I* ICBM's, the *Polaris* IRBM, various unmanned drones and manned craft.

• **Elastomeric suspensions**—Essentially, the job of an inertial system suspension is to protect the system against the dynamic disturbances described here. Non-dynamic conditions covered by typical military requirements—sand, dust, fungus, and climatic conditions—usually are not factors in the system design analysis, because inertial systems operate in carefully controlled, air-conditioned environments and most available materials can meet environmental specifications.

The basic requirement, then, for a protective suspension is that it must have large linear capabilities to perform over the wide range of frequencies and sustained accelerations to which it is exposed. Further, the suspension must maintain its capacity for protection despite the static deflection resulting from the sustained accelerations.

Elastomeric materials are ideal in this type of application because they provide more energy storage capacity, hence greater linearity, than classical systems such as mechanical springs and damper combinations. Elastomers permit simplicity of design combining damping and elasticity in a single package which is compatible with tight-space applications. Resonant frequency control and superior attenuation of high frequencies are provided.

High-frequency characteristics are particularly important; this is the area in which troublesome structural resonances exist and high structural responses can occur in the inertial guidance system. Response characteristics of such components as solid castings, gimbal rings, rotors of the gyros, and accelerometers all combine to present a high-frequency problem far more severe than that of any other currently active application. High-frequency characteristics of a typical elastomeric suspension are shown in Fig. 2.

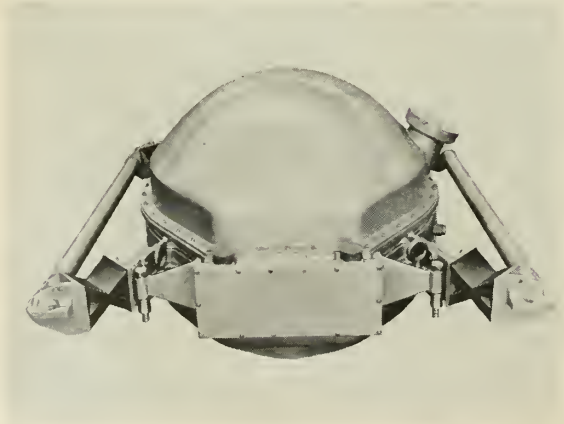
The best reason for choosing an elastomeric suspension instead of a hard mounting is that the elastic characteristics of the attachment points can be much more precisely controlled, both statically and dynamically, through resilient mountings than through a normal production structural configuration. The structural configuration presents the extremely difficult problem of driving each rivet or tightening each screw identically, plus controlling the interface of the mounting surfaces exactly.

It is a fact that flexible suspension of inertial guidance systems has become an acknowledged method of protection. For example, the original hard mounting configuration for the *Titan I* three-axis reference system built by Minneapolis-Honeywell did not prove feasible because of the system's sensitivity to high-amplitude vibration at certain frequencies. A three-point Lord elastomeric system was introduced and now provides the attenuation needed to protect the platform during the power phase of the flight (see Fig. 3).

Weight is another area in which elastomeric suspensions offer advantages. A suspension system design that is 10% of the supported weight has been considered exceptionally good. However, even better ratios than that are now being achieved. For example, the suspension system for the advanced *Atlas* inertial platform built by American Bosch Arma, weighs considerably less than 10% of the supported weight.

Properly engineered elastomeric systems do meet the requirements for minimum space and weight, and provide performance versatility necessary for control of both low- and high-frequency disturbances plus superimposed sustained accelerations.

• **Performance controls**—Effectiveness of an elastomeric suspension system is determined by the performance of



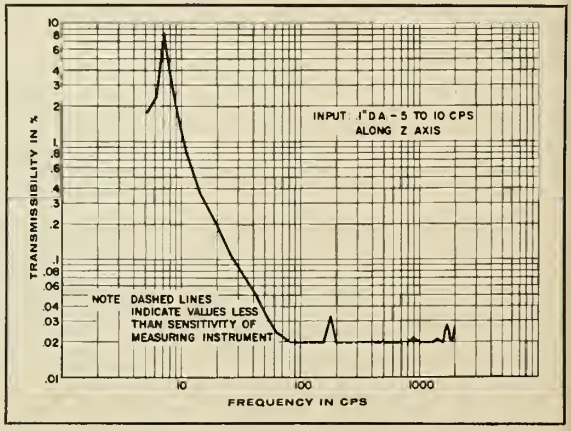
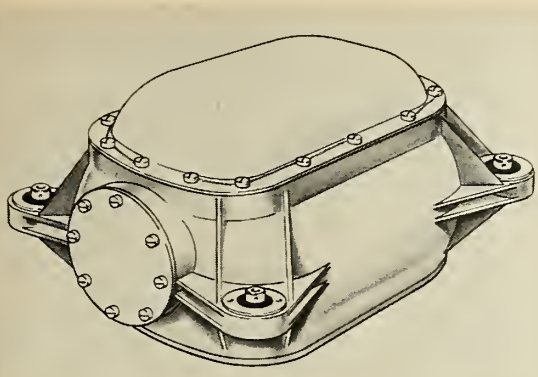


Fig. 4—*Atlas all-inertial guidance platform and curve of typical transmissibility with the X-shaped rubber isolator system designed by Lord.*



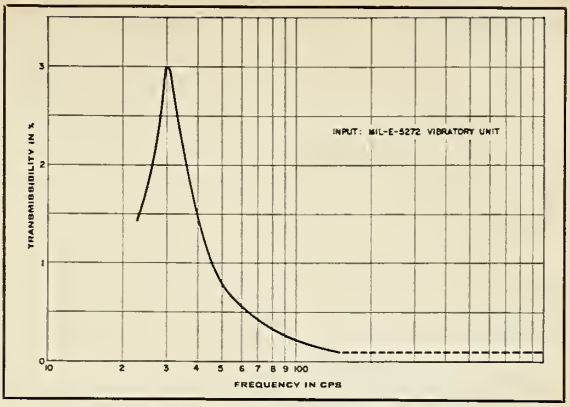


Fig. 5—*Drawing of Centaur inertial platform and transmissibility curve.*

each isolator in the system. Properties must be identical so that the characteristics of the system fall within the allowed tolerance. This does not necessarily imply customization of the elastomer.

Of primary importance are the methods of manufacture, testing and inspection. At Lord, ultimate system performance is controlled by matching each set of isolators dynamically as they go through the production facility. This is accomplished with a phase meter to measure the quadrature point of the relative motion across the isolator and the input excitation.

This method is used because the peak of the transmissibility curve on a highly-damped isolator is so broad that precise location of the exact peak value is not possible. But the slope of the phase curve is steep when passing through the 90° point and any slight deviation from the natural frequency of the isolator is noticeable.

The phase-meter technique, plus the use of a digital counter capable of five-place readings allows measurement of natural frequency to within plus or minus ⅛ cps. Each suspension system, then, is comprised of isolators whose natural frequencies fall within this tolerance.

• **Experience helps**—Inertial system suspensions now used in operational aerospace craft are deceptively simple in appearance. It is, of course, the purpose of the vibration engineer to achieve maximum design simplicity to meet space, weight and reliability requirements. Added to these considerations is the need for absolute protection within the dynamic environments described previously.

Protective suspension design is based on known or predicted vibration tolerance of the inertial guidance system. This is a matter either of testing the equipment, or of having the prior experience and thorough knowledge of the state of the art that make it possible to predict vibration tolerance.

Successful suspensions result when the vibration control specialist knows what is involved—in terms of missiles in general, in inertial guidance systems in particular—and can work closely with design engineers in the field to produce the required performance in the overall system.

• **Typical applications**—Design requirements for the *Atlas* all-inertial guidance platform called for an effective isolation system weighing less than 30 lbs., yet capable of supporting the comparatively heavy guidance package. The final isolation system weighs about 10 lbs.

Arma performance specifications called for maximum transmissibility of 10:1 at input of 0.4-in. displacement amplitude along platform pitch, roll, and azimuth axes. Natural frequency was required to be in the range of 5.5 to 9 cps with an input of 0.4-in. displacement amplitude along each axis.

Lord designed a suspension system comprised of four X-shaped natural rubber isolators. These were symmetrically positioned around the inertial-platform center of gravity and connected by tubular cross members.

Final system performance characteristics were (see Fig. 4):

—Transmissibility: 6.5 to 8.5:1.

—Natural frequency: approx. 7 to 9 cps in each of the three major directions.

—Very high attenuation in the 120 cps region (natural frequency of string accelerometer).

For the Minneapolis-Honeywell miniature inertial platform used in *Centaur* and the Fairchild *SD-5* surveillance drone, Lord designed a system using four broad-temperature-range BTR Elastomeric Mountings. These were dynamically matched to ±⅛ cps and were symmetrically located about the platform CG (see Fig. 5).

M-H specifications called for a system capable of supporting its 28-lb. platform under accelerations up to 10 g and having an operational life of 2000 hours.

Besides meeting these and MIL spec requirements for vibration, shock, and non-dynamic environment, the final system successfully met five other M-H specifications:

1. Max. transmissibility of 3:1 at room temp.
2. Min. natural freq. (Final design was 28 to 32 cps.)
3. Returnability of ±3 min. under static conditions with 20 ft.-lbs. torque applied about any axis.
4. Dynamic misalignment: ±1.5 min. with 0-5G input and ±3 min. with 5-10G input.
5. Vibration envelope: max. motion 0.240 in. with sustained acceleration and vibration. ⌘

AF Tests Use Wire Stretched 20,000 Ft. Up

A 20,000-FT.-LONG copper-clad wire was stretched into the atmosphere off the coast of Florida recently by means of an Aerocap balloon.

Part of an Air Force experiment to study long-distance, low-frequency, electromagnetic propagation, the wire served as an efficient 1-f antenna for the transmitting vessel below. The novel tests were conducted for Rome Air Development Center by Pickard & Burns, Inc., a subsidiary of Gorham Corporation, Needham, Mass.

A 120-ft. former pleasure schooner, "The Azara," was used to carry the wire, which was played out from a high-speed torque drum.

To charge the antenna, a 1-million volt generator was employed. The generator developed low-frequency pulses resembling natural lightning.

The Aerocap is a 90x30-ft. balloon, built and flown by General Mills, Inc., Minneapolis. ⌘

Polaris Testers Buy Predetection Recording

Mincom system for raising volume of telemetry data retrieval wins Navy orders; Dynatronics, CEC producing another system for AMR use

LOS ANGELES—The Navy's first operational predetection recording system has been installed for use in the *Polaris* test program, indicating that the technique will be used increasingly throughout industry.

Predetection recording, designed to retrieve more data from telemetry transmissions, already has greatly enhanced data acquisition through modification, rather than replacement, of existing data retrieval systems.

The technique involves "taping" of a signal directly from an IF carrier, enabling test conductors to use the best detection method for processing each signal because the data is stored in a predetected state.

The system also has a high degree of immunity to tape dropouts; it can be used to simulate complete flights as a checkout for ground equipment. A number of duplicate tapes can be made from the original, with little degradation of data or signal-to-noise parameters.

• **First orders**—The Navy's first predetection recording system utilizes a CM-100 video band recorder/reproducer from Mincom Division of Minnesota Mining and Manufacturing Co. The C-100 takes telemetry data directly from the IF carrier by means of an antenna and a standard receiver using necessary converters.

Initial performance of the Mincom system impressed Lockheed and Navy officials and prompted further orders for the CM-100 setup.

A predetection system being developed by Dynatronics, Inc., and Consolidated Electrodynamics Corp. is expected to be delivered to the Atlantic Missile Range in November for a similar application. This system is unique in that it is the first to be designed specifically for predetection signals. It can simultaneously record both IF and video signals, and also record all types of telemetered signals. It is considered to be a completely new primary telemetry data recording system.

• **PDR technique**—A "typical" predetection recording method described by Mincom's C. S. Tobias consists of heterodyning the IF carrier of a receiver so that a new IF carrier and its sidebands fall within the passband of a recorder, and thus can be recorded and reproduced by use of magnetic tape.

Mincom says its CM-100 is the only currently available model which is completely phase-equalized across the entire passband, a desirable feature in predetection recording.

Predetection recording almost totally eliminates dropouts and their detrimental effects. Recovery of dropouts more than 15 db down is made possible because of the double limiting available through utilization of axis-crossing methods or counter-type discriminators for detection. Signal levels and amplitudes can therefore be widely varied without adversely affecting fidelity or accuracy of reproduced data.

Another advantage is the ease with which prime analog data tape can be copied without degrading the data. The reduction of quality in a normal analog tape makes it almost impossible to get an acceptable product after the third-generation copy, due to increasing phase distortion, ringing, overshoot, undershoot and noise.

Although signal-to-noise levels increase from copy to copy with the predetection recording method, the effects are not serious because the technique is not dependent on high signal-to-noise ratios and amplitude stability.

Mincom also points out that the IF from a specific flight can be recorded directly on magnetic tape, then used for flight simulation to check out ground equipment used in the system. The predetection recording technique can be used with any type of multiplexed FM signal — FM/FM, PCM/FM, PDM/FM, PAM/FM and even combinations like PACM/FM.

• **Steady base line**—Fidelity of the reproduced data is considered quite favorable, eliminating ringing, undershoot and overshoot from the detected video output data. In previously used systems, when data is recorded at one speed and played back on an analog recorder at reduced speed, a base line shift occurs. This is caused by a filtering effect from the low end cutoff point of the recorder amplifier.

(Continued on page 44)

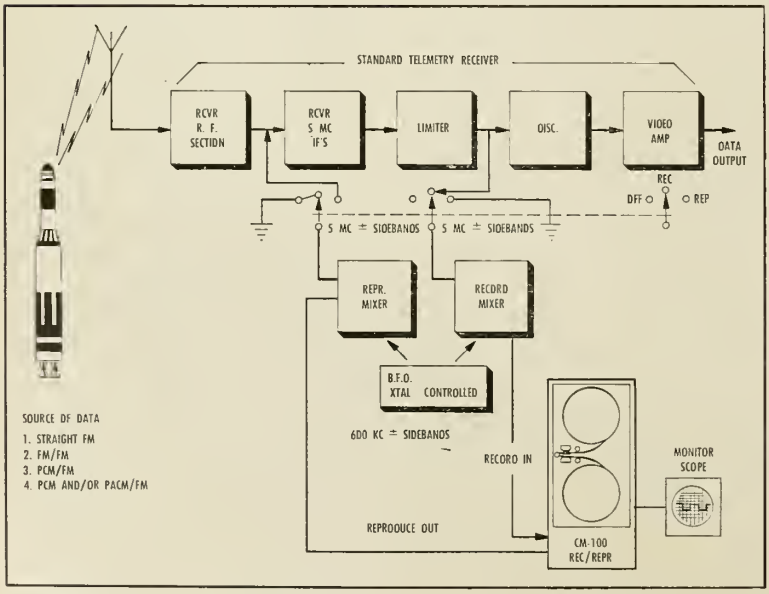


DIAGRAM OF OPERATIONAL PREDETECTION SYSTEM developed by Mincom.

Airmen Live 17 Days on Pure Oxygen

by Heather M. David

NO SERIOUS EFFECTS have thus far been found in the two Air Force captains who breathed almost 100% pure oxygen for 17 days at ⅓ sea level atmosphere in a recent School of Aviation Medicine test.

But SAM doctors report that the unusual environmental conditions produced some irritating effects on the lungs and breathing passages of the research subjects. And one of them lost 6 lbs.; the other 3 lbs.

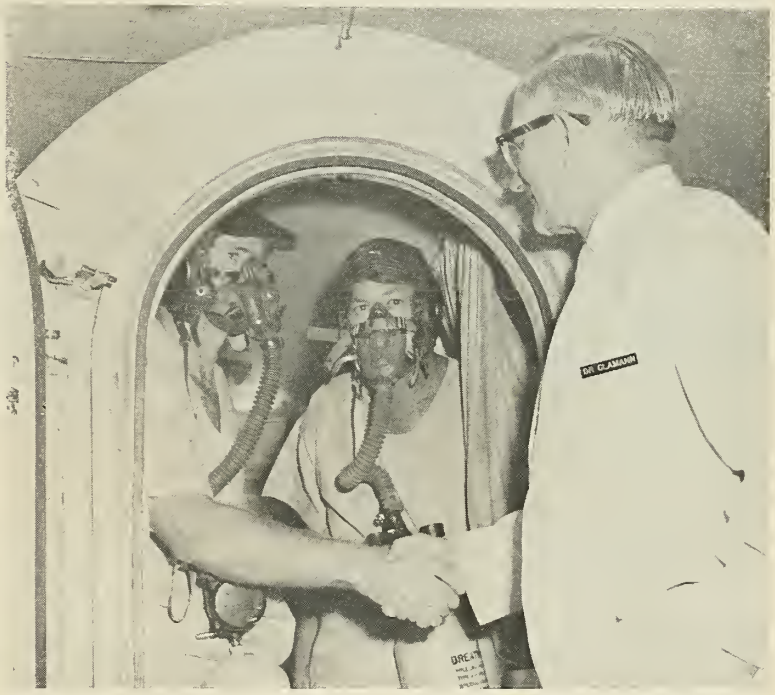
The results are only preliminary. SAM spokesmen say that tests on the two men are still continuing, and similar experiments are planned for the future. Not until many more men are tested and observed for longer periods of time will space physicians decide whether they dare tamper with man's natural environment in designing space vehicles.

Purpose of the experiments is to determine how well potential astronauts can function in a synthesized environment. Because of the problems involved in duplicating a normal two-gas, sea-level atmosphere, U.S. spaceships may carry something less. The two existing life support systems designed for orbital vehicles—*Mercury* and *Discoverer* (animal)—are based on the 100% O_2, ⅓ atmosphere pressure specifications.

The test was the second of its type conducted at the School of Aviation Medicine. Last February, two other subjects were exposed to the same conditions on an exploratory, day-to-day basis.

• **Earlier results**—In the first test, SAM physiologists report, the two men had little or no change in pulse, breathing rates, blood pressure and body temperature. However, both men were weaker and showed decreased heart efficiency immediately after the simulated flight. They also lost weight and "may have become slightly dehydrated." The Air Force said these changes were similar to those which occur after decreased activity.

The Navy Missile Center at Point Mugu, Calif., also has been working in the same direction. Last week two petty officers completed a five-day test in which they breathed 100% oxygen at 34,000 ft. Preliminary results also showed no serious ill effects.



PREPARING FOR "SPACE"—Captains Westfall and Gang wear oxygen masks to flush nitrogen from their systems before going to altitude in SAM Space Cabin Simulator. Despite the precautions taken, both men reported some very minor "bends" during the 17 days spent in the cabin. No serious permanent effects were found.

The School of Aviation Medicine chose the 17-day period because this is the estimated length of time for a circumlunar mission using minimum energy.

Animal tests at the School also seem to indicate that a 100% oxygen, ⅓-atmosphere pressure can easily be tolerated for at least this time period.

The Air Force sees great advantages in a one-gas atmosphere, if it can be proved that man can withstand it for long periods of time without losing efficiency.

A great saving in launch weight can be effected if there is no need to add an inert gas (such as nitrogen) to attain sea-level pressure.

A knotty problem posed by a two-gas atmosphere is maintenance of the proper balance. Oxygen consumption by a one-, two- or even three-man crew would vary greatly during different times of the day. Special instrumentation and controls (at further weight and power cost) would be necessary to keep the balance.

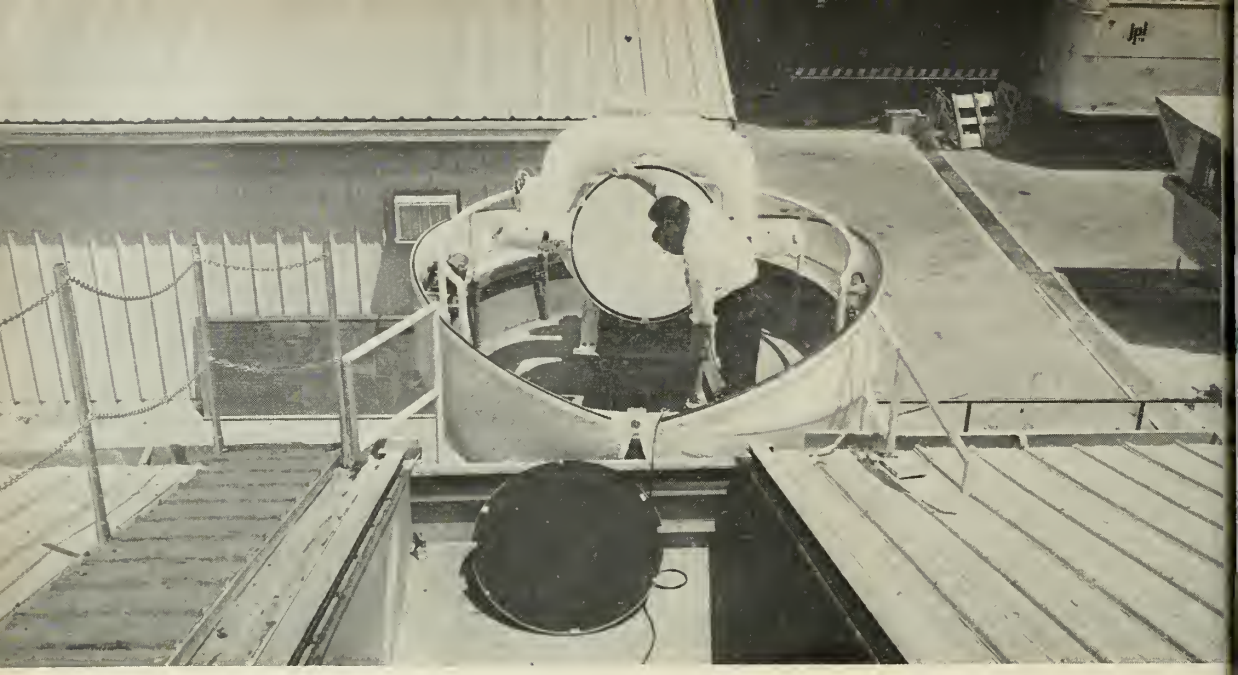
Dr. Hans G. Clamann, professor of biophysics at the School, pointed out in a paper recently that in a pure oxygen atmosphere, "a total-pressure monitor would be a minimally sufficient assessment of the oxygen available to the alveoli." This would greatly simplify the control system.

U.S. scientists already know that a high percentage of oxygen at sea-level pressure leads to severe damage to the lungs, breathing passages and brains—eventually leading to death. The ⅓-atmosphere pressure now appears to provide the correct partial pressure for breathing.

• **Other experiments**—The two Air Force captains also tested out a water recycling unit which was designed by the School.

Capts. Westfall and Gang spent four hours each day performing medical tests

(Continued on page 44)



test facilities

'Most Advanced' Celestial Simulator

JPL's half-million-dollar 'instant universe' will be used to test sensors of the Ranger, other moon vehicles

by John W. Herrick

PASADENA, CALIF.—Attitude control system sensors for the *Ranger* lunar impact vehicle will undergo test and evaluation soon on a new, $500,000 celestial simulator now in final checkout at Jet Propulsion Laboratory.

Other sensing devices—for *Surveyor, Prospector, Mariner* and *Voyager*—will be checked out later in the new facility, said to be the most advanced of its type in the world.

Designed and built, for the most part, by JPL personnel, the "instant universe" can duplicate white light and infrared point sources of solar system bodies likely to be used for navigation and attitude control of spacecraft—the sun, moon, stars and the earth. Both natural sunlight and artificial lights can be used.

Constructed inside a standard building at JPL, the simulator is housed in a 25-ft.-high dome with a totally nonreflecting interior. The 4 x 8 and 4 x 10-ft. structural panels have a specially treated inner face. The fitted panels were painted a dull black and covered with a thick layer of black felt. The final interior layer consists of 8-in.-thick honeycomb, also painted flat black. The end result is a laboratory interior with the total blackness of deep space.

The need for minimum reflectivity is pointed out by JPL scientists because test requirements will involve projection of an intense 3-ft.-diameter sun beam onto a test table while projecting a wall display simulating the earth and moon in the correct colors (as viewed from space) and at chosen phases.

• **Test area**—The basic simulator is a 1000-lb. test table supported just above the floor at the intersection of all light beams. Completely independent, the table rids on a 10-in. gas bearing (nitrogen) to provide three-axis, frictionless motion. This simulated spacecraft body duplicates dynamics of a spacecraft system using light sources as navigation and/or attitude control.

Except for a one-half-thousandth layer of nitrogen gas under the bearing, there is no contact with the building floor or the earth. A 28-channel telemetering system and a 28-channel radio command system link the table to a control room outside the dome. The table has a self-contained power supply of batteries and nitrogen bottles sufficient for full-day operation of table

←

JPL SCIENTIST examines automatic motor-aimed mirror of heliostat that projects 3-ft., perfectly collimated beam of sunlight to second mirror above black-surfaced dome of the Celestial Simulator Facility within which NASA spacecraft sensors will be tested.

circuits, plus three attitude control jets for pitch, roll and yaw.

Because the perfectly balanced table operates in a gravity field, there is a slight mass shift when it tilts away from the bearing's vertical axis. This droop tendency under the 1-g force is compensated by automatic weight-shifting devices attached to the table.

Due to the gravity effect, actual spacecraft bodies will not be table-mounted. However, according to John R. Scull, chief of JPL's Spacecraft Control Section, all elements of a control system can be mounted in their correct relationship on the table and used to position the table as if it were moving through space or maneuvering to a selected plan.

The gas bearing is the clue to making a 1000-lb., box-like mass behave as if it were in space. For test purposes it is necessary to precisely maneuver around the bearing center at all operating attitudes a complex assembly of rate gyros, optical sensors, attitude jets, CG adjusters, power supplies and electronic units.

• **Blows off position**—Sensitivity of the test table was strikingly demonstrated to M/R. The unit was unbalanced simply by blowing a breath of average force against the outer frame. After a few seconds, a series of popping sounds indicated the table was rolling back to its original position under the low thrust of externally mounted attitude jets. The balancing operation was verified by control room instrumentation.

The two-in.-long positioning jets are sized to give the same thrust level and performance as future spacecraft supersonic nozzles will produce in space.

The bearing's 10-in. steel ball, produced by Bearing Specialities, is capable of holding maximum drift of the table to 5-millionths of an inch as it floats on a layer of 80 psi nitrogen. To hold this accuracy, JPL specified 10-millionths maximum deviation from spherical. This accuracy was achieved around one axis, but JPL expects to acquire a more perfect ball in the near future.

Test table inertia is such that, for the same torque, the system will exert the same acceleration as an actual spacecraft. Through a scaling relationship, space performance of flight-type sensors and instrumentation can be studied.

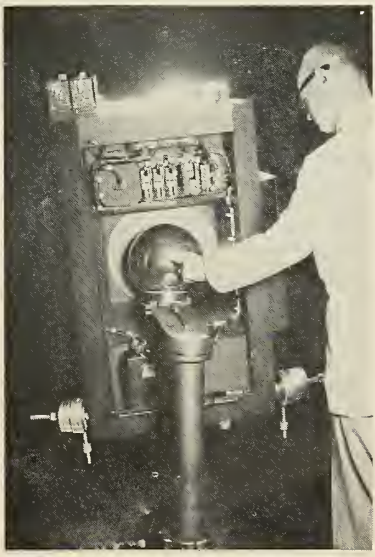
• **Switch to two rings**—Biggest JPL problem with the gas bearing was achieving proper balance with a single-orifice unit. Although unsymmetrical flow of gas around the bearing was only 0.5 standard cu. ft. per min. at atmospheric pressure, torques were induced on the table that the attitude control system could not handle. The flow also caused a somewhat inadequate lateral stability.

The current solution was to change the single-orifice, sonic-flow system to a bearing feed system having two concentric rings of multiple orifices at subsonic flow. An additional bonus was the "stiffening" effect on the bearing with two-ring flow. When the table is not in use or is in a fixed position, a Teflon sleeve lifts the ball off its base to prevent brinneling.

One of the facility's critical tasks is to correctly position light sources at a sufficient distance from table-mounted sensors to reduce focusing problems, and to simulate optical characteristics of certain "space beacons" with the correct color and luminosity.

The celestial simulator can place two accurate light targets anywhere on the dome's interior. Light source plates are held by two curved frames termed "planet source carriers." The carriers are propelled around a 40-ft.-diameter track on the dome's concrete floor by individual variable-speed electric drives.

The same drives, through mechanical linkage, raise or lower light sources along the carriers. Radial center of the moving carriers is the gas bearing which supports the test table. Upper pivot point is a circular track at the top of the dome interior.



PERFECT 10-IN. BALL of gas bearing permits spacecraft-simulating test table (shown here at extreme tilt) to rotate friction-free in any direction around center point of the Celestial Simulator dome.

At present, light sources will be positioned by static measurement techniques employing theodolites and similar instrumentation. In the future, the test table may be used as a calibration fixture, with signals generated by the table's rate gyros transmitted to the control room for remote correction of light source positions.

Provision has been made to modify the light source carriers at some future time to provide programed planetary motions, says Gerald S. Perkins, engineering specialist in charge of the celestial simulator.

• **Matching radiation**—JPL scientists have developed light sources which, with adjustable filters, simulate the earth, moon, or a specific star such as the South Pole Star, Canopus—required for *Surveyor* and *Mariner*. The systems are so designed that the intensity of tailored light reaching sensors on the test table equals radiation received on a spacecraft from a designated star deep in space.

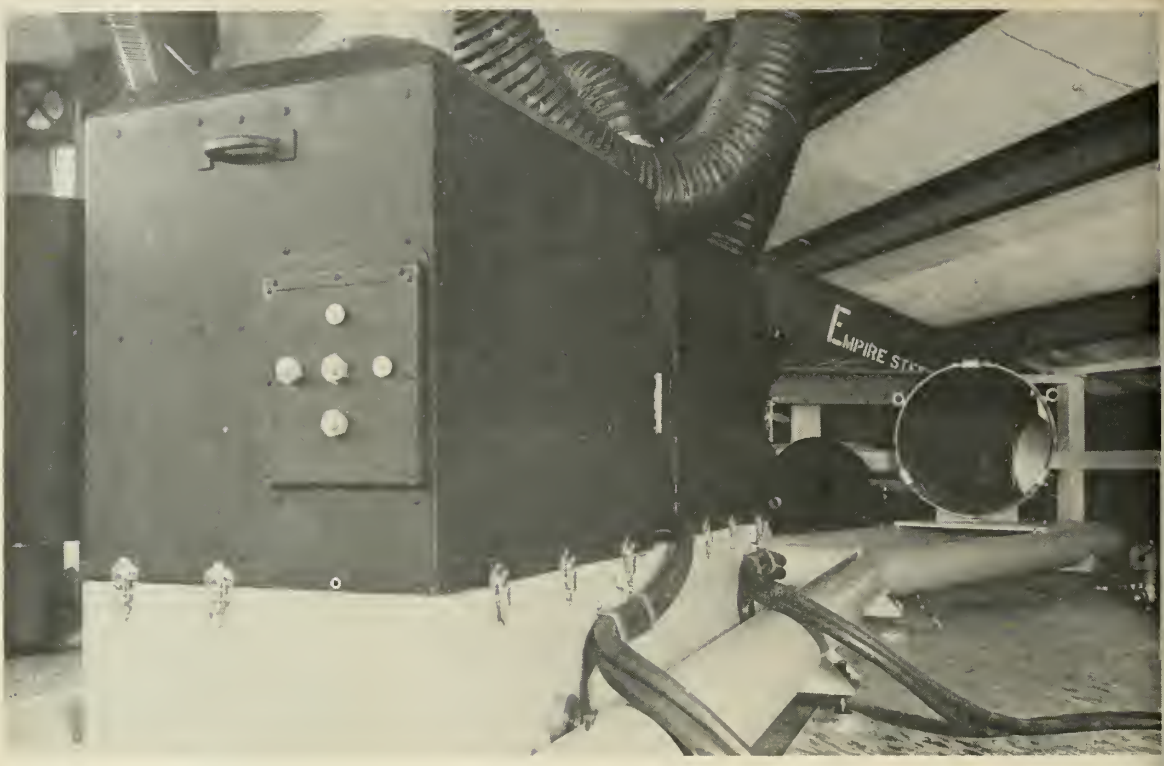
One of the lamps used for earth/moon simulation is made of a high-pressure mercury vapor and argon combination—similar to lamps used in Japan and Germany for motion picture projection.

Much work will be done with infrared sensors to study performance characteristics. In addition to natural sunlight, special JPL-produced IR sources that can simulate the earth's image from distances of 20,000 to 50,000,000 mi. will be held in place on the dome shell by one of the carriers.

Artificial sunlight sources are included in the "space planetarium." Scull said that tests of some components will require a more realistic simulation of the sun in space—particularly at the ultraviolet and infrared ends of the spectrum. In addition, special tests may require night-shift operations or heavy smog may interfere with normal daytime operations.

To provide the artificial sunlight, two heavy-duty arc-lights are supported on rails above the dome. The 225-ampere lights, used one at a time, throw an intense beam onto a corner-located mirror—ground off-axis—which reflects the beam into the central dome mirror.

Inspection mirrors ensure the arc is correctly positioned in the optical system. Anticipating a carbon life of about 40 minutes, scientists designed the arc lights for a quick shift of position, so the second lamp may be brought into the system when the other burns out.



ARTIFICIAL SUNLIGHT BEAM is produced for work area below in JPL's "space planetarium" by alternate-position arc-type lanterns. Note off-axis mirror (at right) to reflect beam over to central dome mirror, out of view. Inspection mirrors ensure that the arc is correctly positioned in the optical system. The lanterns are designed for quick shifting.

One other purpose of using artificial sunlight is to measure the critical distance between a spacecraft and a planet. By changing the arc-light aperture—inserting the correct lens in the optical system—operators can create the exact optical image of the sun at selected distances from Mars or Venus.

• **Unique heliostat**—One exception to simulation is the use of real sunlight. To capture solar radiation, JPL designed a heliostat claimed to be one of the most accurate in the U.S., with a reflected beam quality equal to that obtained by most observatories.

The heliostat, according to Perkins, is the only known installation with completely automatic mirror aiming. The sun beam, collimated within two seconds of arc, is reflected horizontally from the tower-supported heliostat through an opening in the roof of the building housing the simulator.

Accuracy of the motor-driven mirror aiming system is provided by a collimation sensor located in the opening, through which the rays are reflected into the dome by a second mirror above the dome's apex.

Thompson Optical ground both mirrors concave within two wavelengths of light to compensate for distortion by the sun's heat. After approximately 20 minutes of operation, both mirrors —of thickness 1/6 the diameter—are heated sufficiently to become optically flat. A motor-driven turret hood protects the heliostat against the weather when not in use.

The central mirror over the dome opening is fixed in elevation, but rotates manually in azimuth to receive light from the external heliostat or the nearby arc-lamp artificial source.

The celestial simulator will be used primarily for research in space optics, and also in support of the National Aeronautics and Space Administration —in particular to test the dynamics of automatic navigation and attitude systems based upon light sources and the accuracy in alignment a spacecraft will achieve when sighting on such targets. ⌘

Cover Story

Versatile Target Missile Tested

THE ARMY'S NA237 Redhead/Raadrunner is undergoing a series af test firings at New Mexico's White Sands Missile Range.

A ramjet-powered target missile, Redhead is built ta aperate at either high ar law levels. It is capable af flying missions fram 300 ta 60,000 feet altitude and fram subsanic speeds to a velocity af twice the speed af saund.

Built by North American Aviation, Redhead has a diameter af one faot and a length of 19 ft., with stubby triangular six-foot wings. Control is thraugh small rear-maunted stabilizers.

The missile is equipped with an automatic parachute recovery system.

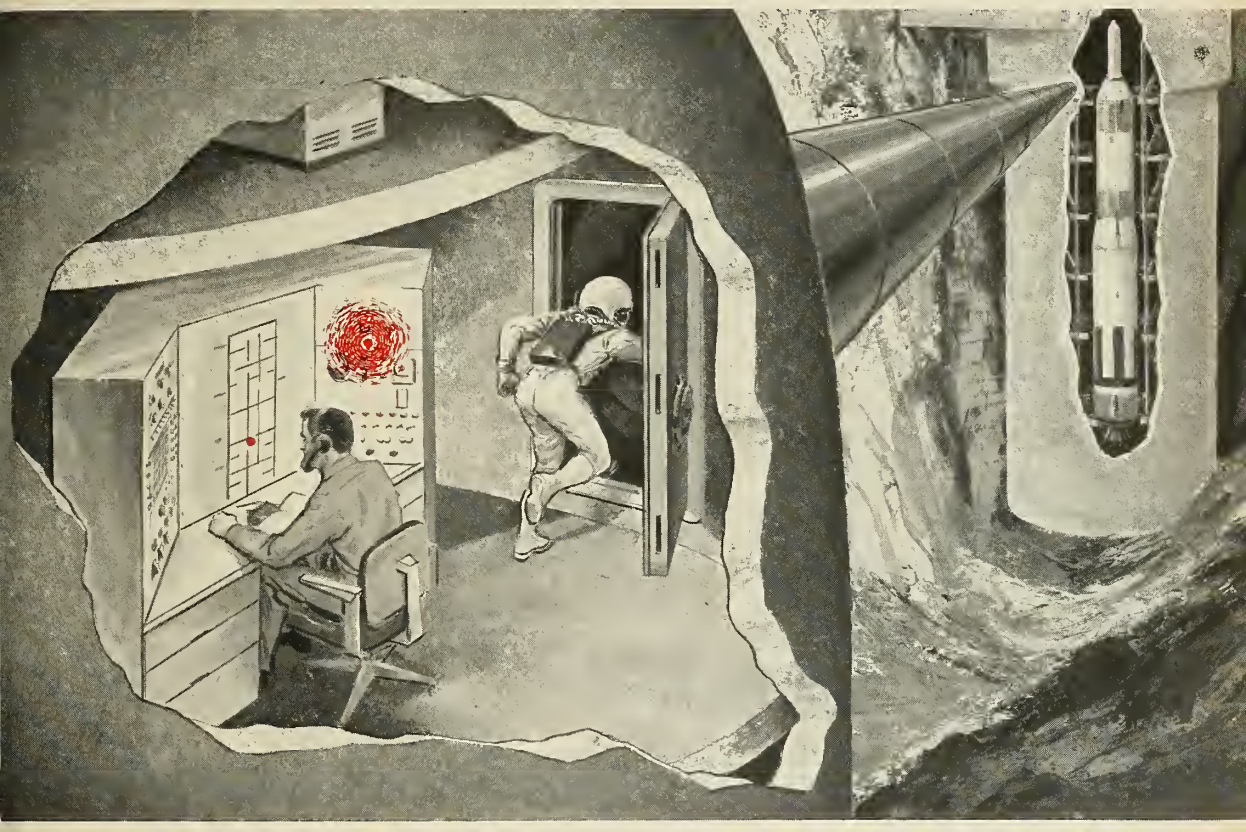
The target missile has been designed as a law-cast item. The Army plans to use it as a target far missile crews of the Army Air Defense Cammand. They will test-fire Hawk missiles at Redhead on low-level flights and Nike-Hercules on high-level runs.

In a successful test launching earlier this manth, the missile was fired from a standard launcher under power of a 6000-lb.-thrust booster rocket. Within five seconds, it reached near sanic speed. Then the underslung baaster fell away and the ramjet engine fired, pushing the target ta supersanic speed.

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NEW VAPOR DETECTOR

Warns instantly of toxic or explosive vapor danger

If you are concerned with missiles or missile fuel handling, consider these features of General Electric's Automatic Vapor Detector safety device:

IT IS EXTREMELY SENSITIVE. As minute an amount as one half part per million of a toxic or explosive vapor can be detected.

IT IS HIGHLY FLEXIBLE. Detector can be easily modified to detect any one of 15 vapors, including hydrocarbons and halogens, and the list is growing. Many areas can be monitored simultaneously.

WARNING IS ALMOST INSTANTANEOUS. The sampling rate of G.E.'s Vapor Detector is approximately five times a second.

EQUIPMENT IS SIMPLE. Only a pump, sampling unit and alarm unit are required. All functions are fully automatic.

This vapor detector has already been selected by the Navy for a shipborne application, and can be tailored for any application where missiles or missile fuels are handled, stored or tested.

Here is another example of LMED leadership in aero/space electronics. 150-01

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GE's New Cryogenic Gyros Near Testing

by Charles D. LaFond



FIRST VIEW of General Electric's new niobium rotor which will be used in an advanced cryogenic gyro now under development. The hollow sphere will next have the lips (top and bottom) removed and sphericity will be achieved to a tolerance of 10^{-5} inch.

CRYOGENIC GYROS that promise to increase guidance accuracy by several orders of magnitude are now nearing the testing stage.

Late this year, first advance versions will be tested at General Electric's Ordnance Department, Pittsfield, Mass., where they have been under development for the past two years. The work is now sponsored by the National Aeronautics and Space Administration's Marshall Space Flight Center, Huntsville, Ala.

Known as Project Spin, the cryogenic gyro concept was conceived at G.E.'s General Engineering Laboratory in Schenectady, N.Y., by Dr. T. A. Buchhold.

The study of superconducting metals had been in progress since 1949. As a fund of experience in handling and using materials at liquid helium temperatures was built up, Buchhold, an inertial guidance pioneer, envisioned a gyro design using these new techniques.

Here then was a new approach which might be able to offer a giant step upward in gyro accuracy and stability, with unheard-of reliability because of the absence of wear. Under a company-sponsored program, the cryo gyro was studied for well over a year. In time a cylindrical shell rotor within a cryogenic motor was built and operated at high speed. Buchhold's idea was conceptually proven.

The idea was sold to the Army Ballistic Missile Agency at Huntsville, and a contract for a prototype development was let in March, 1959.

By January, 1960, first results of the G.E. research effort were demonstrated at the opening of the company's new cryogenic laboratory in Schenectady. Rotor, motors, and non-mechanical bearings for the Mod 0 gyro were revealed for the first time.

During the next six months, all necessary components were built and tested. By late summer, the first gyro was completed and preliminary tests were started.

The goal was to drive the small spherical rotor at speeds up to 20,000 rpm inside a high vacuum and at temperatures down to −460°F (liquid helium).

Early laboratory tests had already proved the feasibility of suspending and rotating a metal body for very long periods in such an environment. But a multitude of questions remained to be answered.

First tests were not wholly successful. G.E. nevertheless feels it learned a great deal with its first units. Early gyro rotor tests never achieved speeds over 2000 rpm, because of undisclosed design problems. Cryo motors, however, were operated at 20,000 rpm.

Other major omissions in the early tests were the lack of test set-ups for measuring gyro drift or coast-down time. Since desired rotor speed was never obtained, such measurements would have been fruitless.

On the plus side, the gyro design principle was proven. That is, the rotor was suspended magnetically at cryogenic temperatures and it did spin under control at rates up to 2000 rpm. Also, for the first time super-conducting currents were developed by the transformers at these same operating temperatures.

Principal problem in the Mod 0 apparently was one of material. The Mod 0 rotor was a hollow titanium sphere coated with niobium. Also for proprietary reasons, G.E. has disclosed neither the specific problem encountered nor the extent of redesign for its new system.

However, in its new Mod 1 cryo gyro, it is known that the rotor will be a very precisely machined, hollow niobium sphere. The original stock will be an ingot of the purest quality niobium obtainable. Final size will be less than 2 inches in diameter and the rotor will weigh about 3.5 ounces.

Since true sphericity is a major characteristic of the finished rotor, it will be superfinished to a roundness tolerance of 10^{-5} inch. Concentricity of the sphere will be measured with the rotor at operating temperature (−460°F).

It is estimated by G.E. developers that the new rotor will be so nearly frictionless it should spin freely in operation for several months to possibly years after it is brought up to speed.

The new rotor fabrication is nearly complete. First test operation is scheduled for late 1961.

With its recently extended development contract, an additional $136,000 in funds was made available by NASA. This brings total funding to about $640,000—supplied by NASA, Advanced Research Projects Agency, Navy Special Projects Office and ABMA.

• **Superconductivity reviewed** — Electrical resistance in some metals approaches zero as the temperature environment nears absolute zero. So far, some 20 different metals and many compounds and alloys exhibit this tendency under such a condition.

The result is obvious: Electrical currents once initiated will flow forever in a superconductive circuit or until deliberately interrupted.

Resistance vs. temperature curves of the common metallic conductors are essentially linear. Near zero, but at some finite point, the resistance value be-

comes constant and the curve levels off.

However, some high-resistance metals, such as tin, lead, mercury, tantalum, niobium, and others, have the unusual property of attaining zero resistance when nearing absolute zero. They become superconductive. The change to superconductivity has been observed to occur very abruptly at temperatures below 10° K.

Superconductors exhibit other unusual but generally useful characteristics:

—Electric conduction occurs only at the surface, and the metal becomes diamagnetic.

—Current in a superconductive coil creates a magnetic field having a constant flux value.

—Up to some finite critical point, a superconductor acts as a magnetic-field insulator. That is, the field introduced induces permanent counter currents on the material surface which block or repel the field.

—A critical field intensity does exist, and causes the superconductor to become resistive. The critical value varies with each material and at different temperatures within the cryogenic range.

—Although losses are still extremely low, alternating currents at very high frequencies (over 10mc) experience some resistance in superconductors.

• **Motors tested**—Key concept in developing the very-low-drift-rate cryo gyro is its associated cryogenic motor.

Using superconducting magnetic bearings having high-load-carrying characteristics, the motors exhibit essentially no internal losses from either mechanical or electrical sources. In the laboratory, motors have been operated successfully using a superconducting rotor in liquid or gaseous helium or in high vacuums.

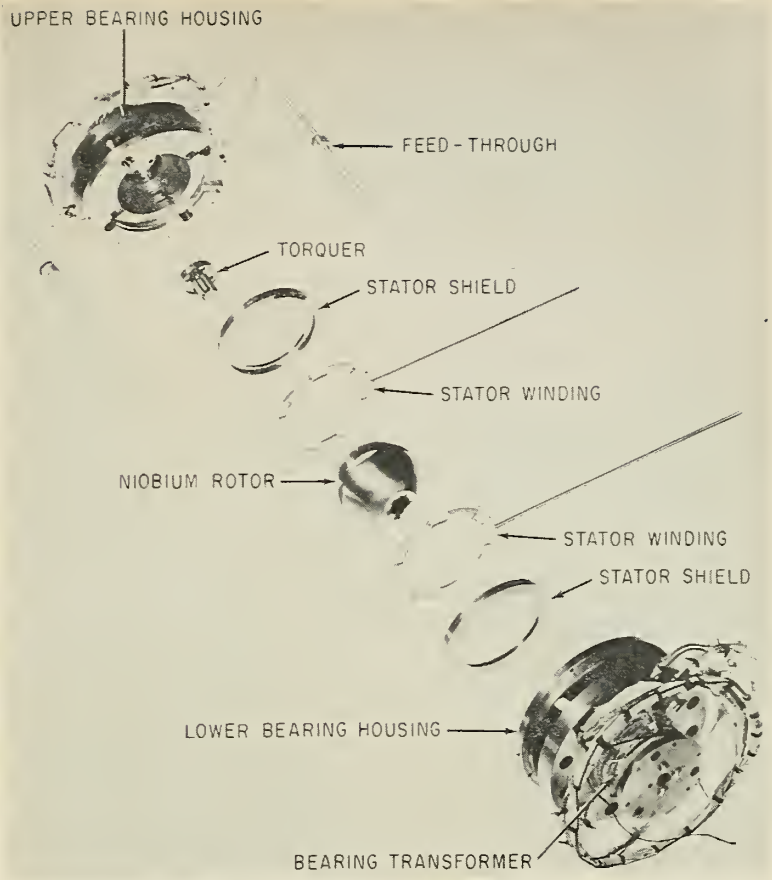
First proposed by G.E.'s Dr. Buchhold, motors were first used in the cryo gyro development program.

They employ niobium superconducting rotors, stationary current and stator field coils to lessen cooling problems.

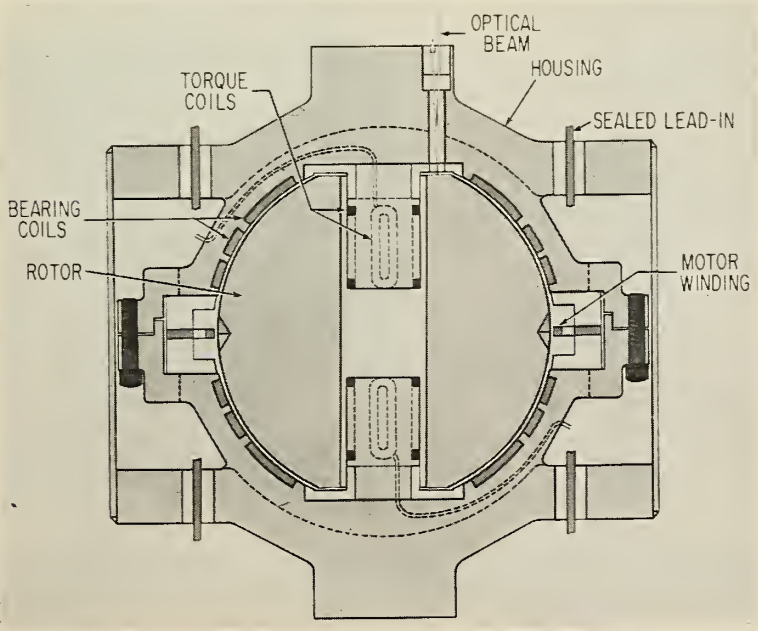
Motor bearings produce both radial and axial rotor support entirely free of mechanical contact with the rotor.

To develop rotor torques, symmetrically oriented grooves (or holes or slots) are machined around the rotor surface opposite stator windings. Torques are developed by both alternating and pulsed direct currents in the superconducting windings about the rotor. Magnetic forces normal to rotor-surface disfigurations produce the required operating torques.

Cryo motors have been operated in liquid helium at rotational speeds up to



EXPLODED VIEW (above) of G.E.'s earlier Mod 0 cryogenic gyro. Units achieved speeds up to 2000 rpm in laboratory tests, but redesigned Mod 1 gyro is expected to reach the desired 20,000 rpm not attainable with earlier version. Cutaway (below) shows assembled configuration.





SLIP RING COMPANY OF AMERICA
3612 W. Jefferson Blvd. / Los Angeles 16, Calif. REpublic 5-0253 / TWX LA-531
or P.O. Box 96 / Tenafly, New Jersey / LOwell 7-5353
Representatives in major cities in the United States and Canada.

1200 rpm, and up to 20,000 rpm under a vacuum of 10^{-6} mm of mercury.

• **Accelerometers pushed**—Concurrent with G.E.'s gyro development is an expanding project to produce cryogenic accelerometers. A $120,000 development contract has just been awarded G.E. by Marshall Space Flight Center in an attempt to gain magnitude increases in accelerometer sensitivity and accuracy.

Units will be built, G.E. says, to operate at temperatures down to −452°F.

• **Broad future**—The real significance of the techniques and processes now being learned in cryogenics, G.E. feels, is their potential in other component areas.

Besides the obvious advantages in new inertial units for missiles and spacecraft, Dr. Buchhold believes we someday will see superconductivity employed in:

—Magnetic lenses for electron microscopes.

—Highly stable frequency and time standards.

—Microminiature switching units for shoebox-size computers.

—Super-accurate current-measuring standards.

—Noiseless and drift-free dc-ac amplifiers.

—And even ultra-high-current carrying power lines. (He indicated that lines envisioned would use half-inch cable carrying up to 10,000 amperes.) ⁂

Sperry Hopes to Couple Light Modulator and Laser

A NEW light-beam modulator using a laser for a light source may some day supplant conventional microwave radar for many space applications.

This belief, held by Sperry Gyroscope Company, is based largely on the division's recent development of a device that modulates light at microwave frequencies.

Two advantages are achieved with the instrument, Sperry says: it is capable of considerably more accuracy than standard microwave radar—and requires much less power.

Such a system might be put to use early for space rendezvous guidance and space communications. In guidance, Sperry says, it would make possible a constant stream of precise position information between fast-moving or rapidly-closing spacecraft; in communications, a vastly increased amount of data could be transmitted with relative ease.

The device was developed at the division's infrared and optics laboratory in Great Neck, N.Y. ⁂

Circle No. S on Subscriber Service Card

Novel Integral Nozzle Perfected

Haynes Stellite asserts capability in field of refractory metals, sees big aerospace markets

by John F. Judge

KOKOMO, IND.—An experimental tungsten-graphite integral rocket nozzle has been perfected by metallurgists at Haynes Stellite Co., division of Union Carbide.

Data derived from three tests by a major propulsion firm showed a complete lack of erosion and crack formation. Haynes spokesmen see no major problems in scaling up to flightweight nozzles with the technique.

Details of the nozzle were not disclosed, but the unit is not merely a tungsten liner with a graphite heat sink back-up. The nozzle is produced as a composite and machined as such. The graphite element eliminates hot spots and subsequent burn-through because of its thermal conductivity.

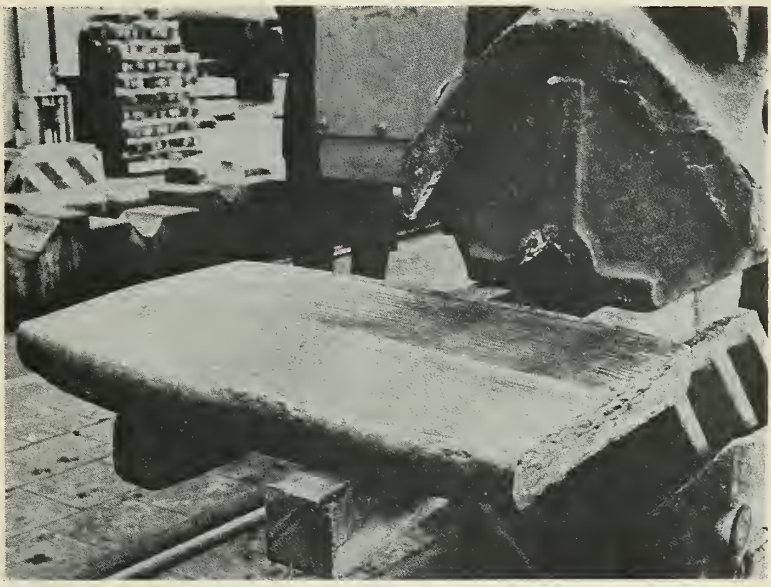
The nozzle shape posed a problem, as did the formation of a liquid interface between the tungsten and the graphite, but the firm found solutions.

• **Weldable Cb alloy**—In the refractory metals area, Haynes is producing a new high-strength columbium-base alloy. Designated Haynes alloy Cb-752, the composition is amenable to conventional fabrication methods and forms a ductile weld joint.

The material has an ultimate strength of over 25,000 psi at 4200°F. The alloy contains 10% tungsten and 5% zirconium and is available in sheets, plates and bars. It exhibits no heat embrittlement.

The firm also completed integrated and specialized facilities for the production of columbium, Nb 1% Zr, vanadium, tantalum and tungsten. Wrought forms of columbium, the columbium alloy and vanadium are available as production items, in addition to the wrought tantalum products and hot-pressed tungsten shapes in production for several years.

Part of the new capability is a 300 kw electron beam furnace built by Temescal. The unit has just started shakedown service. The productivity and economics of the furnace varies widely according to the particular material being melted and the extent to which it is free of volatile impurities.



FORGED SLAB OF PURE COLUMBIUM after cold-working from 6-in.-diameter round. Milling operations and cold-finishing Sendzimir will reduce it to thin sheet.

The furnace itself is tied in with other specialized equipment including a consumable electrode vacuum arc furnace, vacuum annealing facilities and a welding dry box. A 2000-ton forge press, standard sheet, plate and bar mills, a Sendzimir cold-finishing mill and wire drawing equipment are used in subsequent steps in the production of wrought refractory metals.

• **Confused market**—Haynes, like other refractory producers, finds it difficult to accurately define the overall refractory metal market. The firm approaches each segment separately.

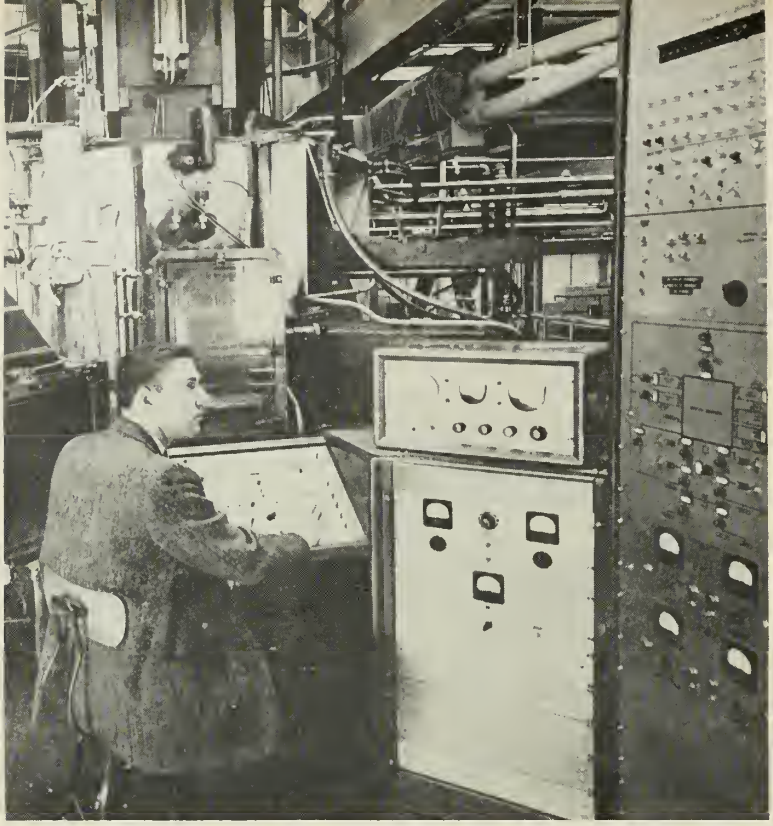
The area is broken down further into a classical market and what is termed "new concepts." The classical product includes such things as tungsten filaments and the like. The new concepts market is primarily in the missile/space and nuclear areas. Haynes is interested in the latter.

The firm does not depend on the refractory market. The same equipment, more or less, produces the tough Haynes alloys chiefly composed of cobalt, chromium, nickel, molybdenum and tungsten and used in aircraft engines.

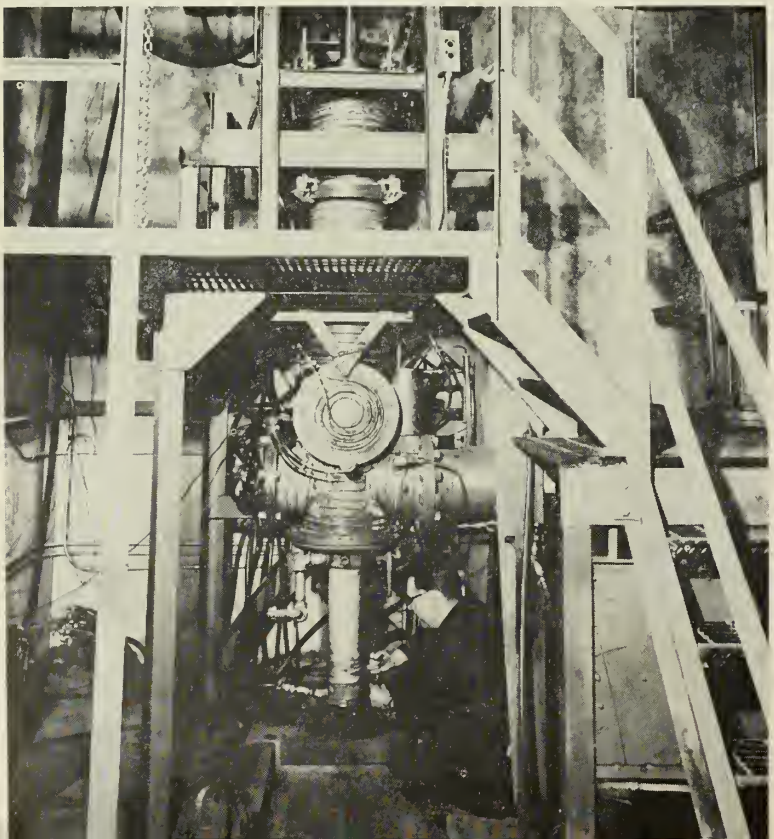
Over 11 million lbs. of tungsten were produced by U.S. firms last year and around 300,000 lbs. went into various nuclear and rocket applications. Haynes feels there is a fairly well defined market in the rocket field for tungsten nozzles. The firm has been experimenting with the hot-pressing of tungsten alloys, tungsten carbide, tantalum carbide, hafnium carbide and 80 Ta– 20 HfC. The integrated nozzle is another application.

Haynes spokesmen see some movement towards columbium, especially as a backup for molybdenum in the high-temperature aerospace field. Columbium and its alloys fit in the picture as leading edges, skins, fasteners and structural components.

• **Oxidation headache**—The Union Carbide division has a capability in strip, sheet, rod and tubing forms in this family of alloys. The biggest stum-



ABOVE: *Electron beam furnace operation is closely monitored by an operator through a direct-vision window. Constant vigilance is maintained by trained observers throughout the entire melting cycle.* **BELOW:** *A view of Haynes consumable electrode vacuum arc furnace.*



bling block in the aerospace applications of columbium and its alloys is the oxidation problem. The full potential of these materials depends strongly on the development of adequate coatings.

A great deal of work is progressing in protective coatings around the country, most of it in government labs or government-supported. Haynes itself does not have any active program in the refractory protective coating area. The firm has placed its emphasis on taking the refractories out of the laboratory-curiosity stage and making them available in the sizes, quantities and forms needed by an advancing technology.

The oxidation hurdle is one of degree. Many applications have been found wherein short-term protection is sufficient—when the refractory metal performs its function before its useful life is over.

Haynes spokesmen say that vanadium seems to be gaining interest as a potential nuclear material. Columbium again may capture more of this market, particularly in fuel cladding applications.

Tantalum's big advantage is its inertness to most of the common corrosive media. The main market area seems to be in the chemical processing industries.

The refractory market, according to Haynes, is a specialty area. It is described in terms of individual applications and missions, and even these are in a state of flux. But the company is confident there will be a need for wrought refractories in the foreseeable future. ⌗

Space Flight Control Simulator Operational

An automatic controls evaluation simulator capable of duplicating control of a vehicle in space as close as possible is in operation at Chance Vought's Astronautics Division, Dallas.

The simulator, dubbed ACES, is an aluminum tubing platform measuring 12 ft. in length and weighing about 1350 lbs. The unit's base is a 4.5-in. steel ball supported on a column of nitrogen gas at 120 psi pressure.

ACES can rotate 35° in pitch or roll and twirl freely in yaw except when connected to the control console by wiring. It is equipped with eight reaction jets.

For manned operation, the platform has a seat, a side-mounted controller and foot pedals. An instrument package in front contains rate and attitude gyros and associated electronic equipment.

Detailed programs will include studies in electronic circuitry, sensors, fuel and power consumption, interaxis coupling and desaturation problems. ⌗

Vigilant Scores in 12 of 13 Shots

Antitank weapon shows rapid firing ability and accuracy in demonstration for NATO officers; sole miss due to rare wire malfunction

LONDON—Vickers *Vigilants* scored 12 hits out of 13 shots fired at Centurion tanks in the first public demonstration of the antitank missile.

The weapon, using dummy warheads, was shown earlier this month before high-ranking officers from France, Britain, the U.S. and other allied nations, plus the Russian military attaché. Vickers is trying to sell *Vigilant* to NATO countries and the British Army.

Earlier this year, it was demonstrated to leading NATO officers (M/R, June 12, p. 45). The British Aircraft Corp. says production can be in full swing within six months if they receive orders.

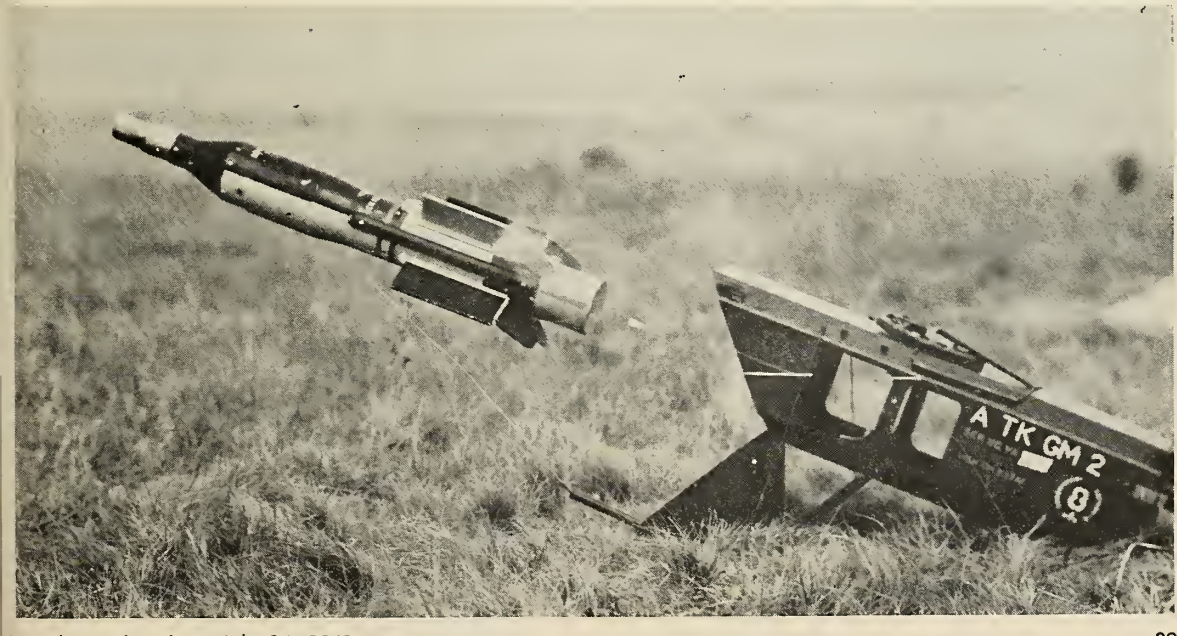
The 49-lb. weapon includes the missile itself (31 lbs. in flight), carry box (which also serves as launcher), pistol-grip control unit, vest-pocket battery and a drum of cable to connect carry-box and control unit. The whole is light enough to be carried on the back or dragged single-handed by a crawling man.

The missile is ready-armed in its box, and pre-firing preparations take only 30 seconds. The soldier snaps open the hinged lid of the box to prop up the box front (the missile is fired at an initial angle of 30° to clear the ground). He aligns the box in approximately the right direction and runs out the cable as far as he thinks necessary—maximum 75 yds.—but because the propellant is smokeless and there is no flash, the firing point is practically undetectable.

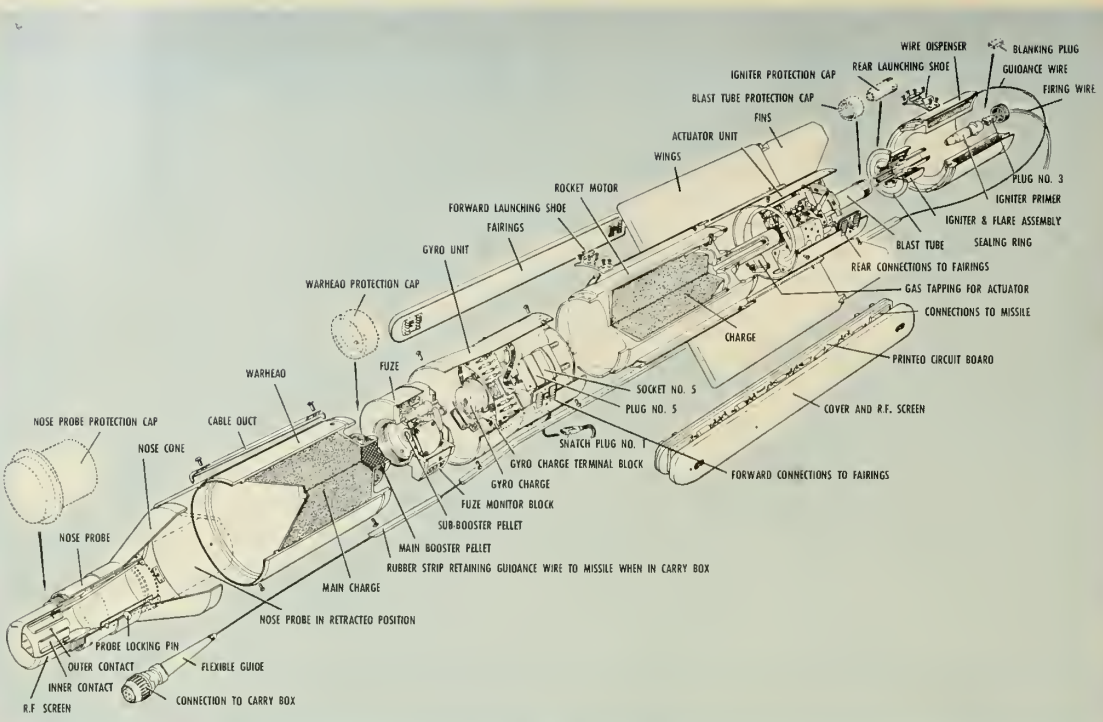
The firing sequence is simply to pull the trigger at the front of the grip and steer the missile into its target. A flare is burned inside the rocket exhaust; the infantryman guides the missile until the flare is superimposed on the target, and then keeps it there until impact. His control is a small box fitting over the thumb behind the pistol grip. Moving the thumb from side to side moves the missile from left to right, and moving the thumb backwards or forwards moves it up or down.

Signals from the control are sent along a wire paid out from an annular dispenser around the rocket exhaust. This contains about a mile of wire. A binocular sight is provided on the grip unit.

• **Angles of attack**—In the latest demonstration, at Warminster, 13 shots were fired by two men at four Centurion tanks presenting different targets. Twelve scored hits. The first six tests



VIGILANT takes off from launcher during demonstration. One round—even without warhead—punched a hole in tank's armored skirting.



EXPLODED DRAWING shows relatively simple construction of Vigilant.

were at individual targets approaching in different ways from a copse about a mile away and moving over "moon country"—rough chalky grassland studded with craters from previous artillery exercises. The tanks are able to travel at about 12-18 mph on this land.

These six tests resulted in hits at ranges of 1350 (in clump of trees), 1100, 1250, 1000 (target crossing, low down), 700 (head-on) and 400 yds. The last was designed to represent a short-range intruder appearing suddenly when the men were engaged with a long-range force.

In the final test at Warminster, four tanks approached simultaneously from different directions and the two infantrymen were told to fire as soon as they could see them. The two men hit all four in 48 sec.

• **Selling points**—The British Aircraft Corp. points out the following advantages of *Vigilant* over other antitank weapons:

1. Method of control. *Vigilant* has a closed-loop velocity control system; others use acceleration control. Velocity control brings the missile onto the correct course rapidly, increasing the chance of hitting the target at close range.

2. It is a one-man weapon. No "black box" is needed along the missile—all the innards are inside. *Vigilant* is readily portable.

3. It is in instant readiness. It can be set up in about a minute; after the button is pressed, it can be off in 30 sec. Hardly any power supply is needed—the operator has a vest pocket battery which is used to start the missile. After initial impulse, power is generated inside the missile by a turbogenerator running off the exhaust gases.

4. From a fixed position of the box-launcher (readily changed by hand), the *Vigilant* can be directed after firing at any target within an 80° angle.

A possible objection to *Vigilant* is its initial cost, twice that of its competitors. No figures are quoted by BAC, but cost is probably in the region of $1400 per round. ⁂

Burner to Treat Titan Vapors

TOXIC VAPORS generated during *Titan II* fueling operations will be removed with a portable, high-capacity burner developed by Avien, Inc.

One of the major problems in the handling of storable propellants is the safe disposal of waste toxic vapors. The Avien Pyron system effectively treats these vapors, reducing the concentration of efflux into the atmosphere to bring it within the allowable limits defined by the American Conference of Governmental Industrial Hygienists.

The system consists of two burners, one each for fuel and oxidizer. The burners have a reactor and a control system, together with associated propane tank assemblies and vaporizing apparatus. The reactor is a horizontally mounted cylindrical stainless-steel furnace lined with firebrick and insulation.

Toxic vapors are fed directly into the burner from point of origin. An automatic flow sensor on the unit activates it when the flow surpasses a predetermined level. The vapors are detoxicated in the reactor, using propane gas. The system can be operated from its control panel or remotely, either automatically or manually.

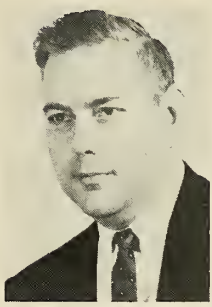
Should a malfunction occur, the system immediately shuts itself off and indicates on the control panel the source of trouble. Thus, non-decontaminated vapors are never released.

The Pyron units can withstand shocks up to 20 g's. Input toxic flow rates may range from 2 to 440 SCFM. The system automatically compensates for the incoming vapor quantities.

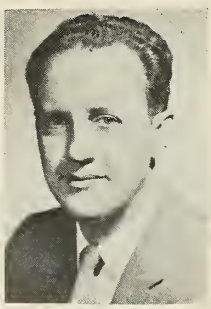
The actual reaction process operates at lower temperatures than normally associated with this type of equipment. Besides conserving fuel, this avoids the problems associated with extremely high temperatures. ⁂

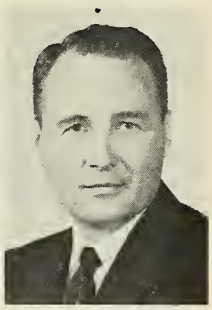
names in the news


CONANT


SHORE


WEITZEN


HOLDAM


PROBST

Dr. F. Karl Willenbrock: Associate dean of engineering and applied physics at Harvard University, appointed senior consultant of the Sperry Rand Research Center to be dedicated later this year in Sudbury, Mass. Dr. Willenbrock will act as research director during the summer university recess and return to Harvard in the fall.

N. V. Petrou: Former engineering manager, appointed general manager of Westinghouse Electric Corp.'s Air Arm Division, Baltimore.

Frederick W. Conant, retired executive vice president of Douglas Aircraft Corp., and **Bertram N. Snow,** retired vice president of The Garrett Corp., elected to the board of directors of the recently-formed Titan Chemical Corp., Los Angeles.

Clifford H. Shumaker: Chairman of the Department of Industrial Engineering of Southern Methodist University, named president of The American Society of Mechanical Engineers.

David Shore: Appointed program manager for Radio Corporation of America's role in Project *Saint.* Shore formerly was associate director of Advanced Military System Group.

William Weitzen: Former Deputy Assistant Secretary of U.S. Air Force for Development, appointed regional vice president, Washington, D.C., Area Operations of Autometric Corp.

Dr. Lawrence L. Kavanau: Formerly manager of aerospace sciences in Space Systems Operations, Aeronutronic Division of Ford Motor Co., appointed Special Assistant for Space in the Office of the Director of Defense Research and Engineering, Department of Defense.

Dr. Kavanau has 15 years of experience in missile engineering, rarefied gas dynamics, heat transfer, hypersonics, experimental research, and research management and planning. At Aeronutronic, he had major responsibilities in the *Far Side, Shillelagh, Decoy* and *Blue Scout* programs.

Raymond Hamada: Former vice president of Telecomputing Corp. and general manager of its Whitaker Controls Division, joins Houston Fearless Corp., Beverly Hills, Calif., as senior vice president-operations.

Dr. Christopher J. B. Fincham: Promoted to technical director of Metals Division, National Research Corp., Cambridge, Mass.

Brig. Gen. Irving L. Branch: Former assistant chief of staff for nuclear systems development and chief of the Aircraft Nuclear Propulsion office, assigned to command Air Force Flight Test Center, Edwards AFB, Calif. **Maj. Gen. Robert H. Warren,** whom the Air Force previously announced would fill this assignment, has been assigned as commander, Air Force Systems Command, Air Proving Command Center, Eglin AFB, Fla.

Arnold K. Weber: Former director of manufacturing, promoted to staff vice president-manufacturing, Radio Corporation of America, New York City. **John H. Sidebottom:** former administrator, marketing staff, appointed division vice president, defense marketing, RCA.

J. V. Holdam: Elected vice president of Dresser Industries, Inc., Dallas, Tex. Prior to joining Dresser, Holdam was a vice president of Laboratory for Electronics.

Dr. James A. Fay: Professor of mechanical engineering at Massachusetts Institute of Technology, will spend a year's leave of absence as a principal research engineer at Avco-Everett Research Laboratory.

James B. Edson: Formerly with Missiles and Space Division, Raytheon Co., joins the Instrumentation Section, Aerospace Research, Inc., Cambridge, Mass.

Alan B. Dallas: Appointed director of field engineering, Consolidated Systems Corp., Monrovia, Calif. Formerly Dallas was regional manager for Minneapolis-Honeywell's Military Products Group.

Frank R. Herud: Formerly with Rockets Division of Textron Co., appointed manager of rockets marketing for Bell Aerosystems Co., Buffalo, N.Y.

Stanley E. Benson: Former systems staff manager, Military Products Division, appointed manager of long-range planning, General Dynamics/Electronics' Marketing Division, Rochester, N.Y. **Charles R. Green:** Formerly with Admiral Corp., appointed chief engineer of the Communications Laboratory in GD/Electronics' Military Products Division.

John R. Kimberly: Chairman of the board of directors of Kimberly-Clark Corp., elected a director of Corning Glass Works, New York City.

David L. Anthony: Named manager of component production, U. S. Sonics Corp., Cambridge, Mass.

Edward P. Farnsworth: Named senior staff engineer, Advanced Sciences Division, Laboratory for Electronics, Inc., Boston, Mass. Before joining LFE, Farnsworth was project engineer at Raytheon's Missile and Space Division.

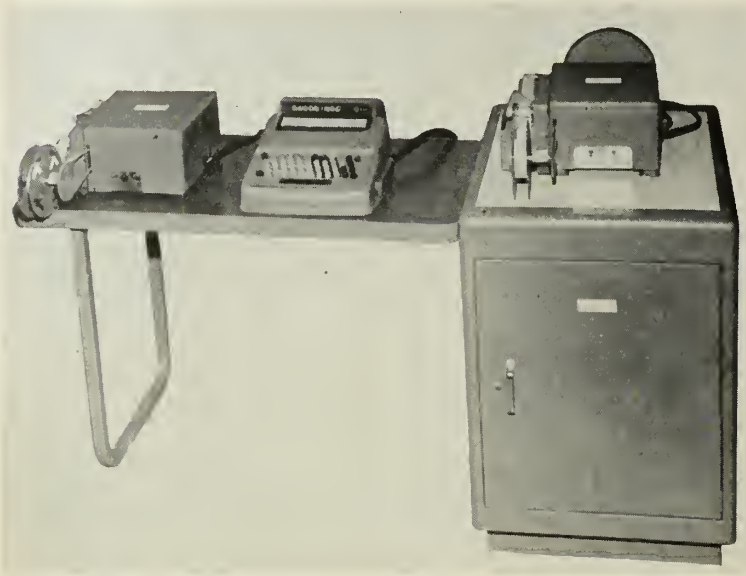
C. Daniel May, Jr.: Joins the Communications Systems Center of International Business Machines' Federal Systems Division, Rockville, Md. Formerly May was chief civilian manager of the Defense Communications Agency's directorate of operations, Department of Defense.

James C. Callaghan: Appointed manager of the Operations Staff, Space Systems Operations, Aeronutronic Division of Ford Motor Co. **Phillips Eastman, Jr.,** succeeds Callaghan as manager of the organization planning department.

M. Clayton Burgy: Program manager at Hercules Powder Co.'s Bacchus Plant, named manager of contracts administration in the Chemical Propulsion Division of the company's Explosives Dept.

Gerald G. Probst: Former chief of radio-inertial division of guidance and control development, AF Ballistic Systems Division, Los Angeles, joins the staff of the chief engineer at Univac, St. Paul, Minn.

Dr. L. Curtis Foster: Former director of research, elected vice president, Zenith Radio Research Corp., Menlo Park, Calif., a subsidiary of Zenith Radio Corp.



Code Tape Punch/Verifier

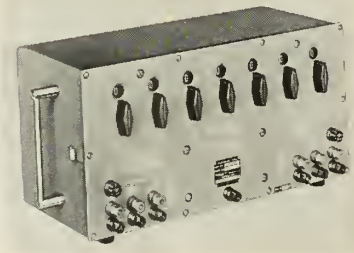
Systematics, a division of General Instrument Corp., is marketing the Model D875 Universal Code Punch and Verifier System. The Model D875 is designed to provide a fast, accurate and economical means of manually punching and verifying from an original document into paper-tape machine language. The system has combined tape keypunching and verifying functions into one integrated system, eliminating weaknesses inherent in makeshift approaches to the preparation of input to paper tape-oriented computers.

The unit punches and verifies for all systems—5, 6, 7, or 8-channel tape, any code structure. The system is built around the same keyboard used on the IBM Card Punch—the best-known keyboard in the data processing industry. The D875 System consists of an alphanumeric keyboard, a paper tape punch, a tape reader, and interconnecting control circuitry. In addition to keypunching and keyverifying, the system is capable of flexible tape duplication—automatically or intermixed with punching and verifying—at any speed up to 20 characters per second.

Circle No. 225 on Subscriber Service Card

A-C Ratio Standards

Gertsch Products, Inc. is marketing a line of precision ratio standards with a-c ratio accuracy to 0.0001%. Units are certified in terms of a standard which is directly traceable to the National Bureau of Standards. Designated Series 1000, these instruments are precision transformer voltage dividers combined with precise resistive dividers. Basic ratio sections include high-frequency a-c, low-frequency a-c, and d-c. A-c sections feature maximum ratios up to 1.111111, and minimum ratios down to −.11111. Units provide switching transient suppression, 6- or 7-place resolution, and terminal linearity of 0.0001%.



Circle No. 226 on Subscriber Service Card

Glass Antenna Reflectors

Close-tolerance fiber glass antenna reflectors which could be used to measure radiation from other planets soon will be marketed to government and industry agencies by The Boeing Co. Capable of holding their shape under heavy wind forces and extreme temperatures and giving stronger focus to radio waves, antennas equipped with the new reflectors could also be used to track satellites or to transmit and receive long-range communications.

Circle No. 227 on Subscriber Service Card

Size 8 Resolvers

Daystrom's Transicoil Division has available a complete line of Size 8 Resolvers which meet light weight and temperature-stable applications. The transicoil resolver is designed so that stability is accomplished without an increase in weight. Stability over the entire temperature range (−55° to +125°C) is inherent in the design. These units are constructed of corrosion-resistant materials throughout and comply with all applicable portions of MIL-E-5272.

Circle No. 228 on Subscriber Service Card

Decommutation Station

Parsons Electronics is marketing a PAM/NRZ/PDM telemetry decommutation station with design simplicity and operational flexibility. Standard IRIG telemetry signals and non-standard rates from the output of a telemetry receiver, subcarrier discriminator, tape, or signal simulator are accepted, processed and demodulated by Model 5400. Major components of the system are pulse selector, gate generator and patch panel, power supply, and combinations of demodulator chassis and plug-in units. Building-block construction permits expansion of basic station capabilities up to 100 channels.

Circle No. 229 on Subscriber Service Card

Miniature Time Delay Relay

A solid-state timing device in miniaturized version is available from Accutronics, Inc. as either delayed break after make or delay on make. These units provide delay periods of from 0.025 to 180 seconds and may be had as either fixed time or variable assemblies. They are manufactured in compliance with all applicable MIL specifications. Standard relays are DPDT 2.5 A resistive; input voltage 22 VDC to 30 VDC. Timing intervals remain constant over a wide range of environ-



mental conditions and will withstand 100 g shock for 11 milliseconds and a vibration of 55 to 2000 cps at 30 g. These units comply with all requirements of MIL-E-5272C for environmental conditions. They are completely encapsulated and have glass-sealed headers in standard MIL enclosures.

Circle No. 230 on Subscriber Service Card

Linear Accelerometer

A hermetically-sealed 3-axis linear accelerometer with range capability all the way from ±2 g's to ±200 g's is available from Humphrey, Inc. The



miniature device provides information on linear acceleration along three different axes, replacing multiple instruments and saving space, weight and cost. Accuracy of the instrument is 1%. Three 5000-ohm potentiometers provide the output. The unit is suitable for rugged environments such as are found in missile applications, including operating temperatures from 0°C to 100°C, shock of 30 g's for 20 milliseconds and vibration without damage of 10 g (0.06 DA MAX) 5-2000 CPS. It can be used at unlimited altitude and 100% humidity.

Circle No. 231 on Subscriber Service Card

Cryogenic Sensors

Two cryogenic sensors, each about the size of a nickel and said to accurately measure temperatures as low as 4° Kelvin (−260°C), have been introduced by Minneapolis-Honeywell Regulator Co. The tiny sensors are germanium semiconductors, designed for application in test and operational phases of space vehicles using liquid helium and nitrogen, and for use in calibration and standards laboratories. Their temperature range is 4° to 40° Kelvin (−269°C to −233°C). One type of sensor measures surface temperatures; the other is a probe-type unit for internal applications. Both are encapsulated and hermetically sealed. Thermometer elements are precision-doped with special impurities to provide high thermometric sensitivity.

Circle No. 232 on Subscriber Service Card

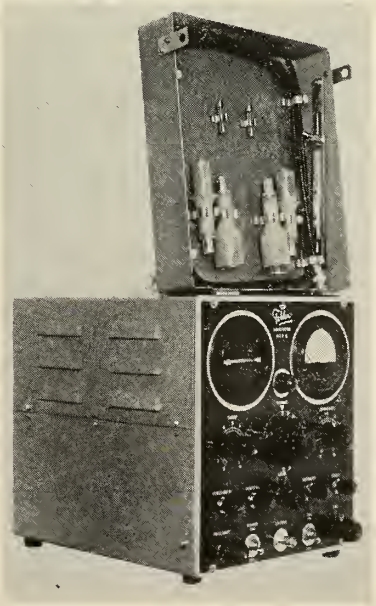
Fiber Optics Cathode Tube

Development and availability of cathode-ray tubes with fiber optical face-plates is announced by the Electronic Tube Division of Allen D. Du Mont Laboratories. The use of fiber optics permits the image, trace, or display on cathode-ray tubes to be brought directly to the outside surface of the face-plate so that all parallax is eliminated. Normal light transmission efficiency of about 6.3% using a lense system is increased to 85-90% using Fiber Optics Cathode-Ray Tube or Coupling. Although the first available Du Mont fiber optics cathode-ray tubes are 1-7/16-in.-diameter tubes, the firm can provide tubes in sizes up to 5-in.-diameter and will undertake development programs for large display tubes where the matter of parallax is of major consideration.

Circle No. 233 on Subscriber Service Card

Adhesive Bond Tester

In direct proportion to the growing application of bonding is the need for rapid, non-destructive methods of testing the strength of such bonds. One of the leaders in this field, the Dutch firm, Fokker Aircraft, has perfected an apparatus for testing various forms of adhesive bonds without in any way applying destructive forces to the bonded materials. The unit is equipped with a probe, which is placed on the area to be tested. The bonded structure is then "tension-loaded" in the same manner as during flight; that is, laminates in shear-tension and sandwich configuration in flatwise-tension. The bond tester simultaneously measures the results of the probing on two parameters, by



which a thorough indication of the quality of the bond is obtained. In actual application, however, one parameter is usually sufficient.

Circle No. 234 on Subscriber Service Card

High-Temperature Diodes

General Electric's Power Tube Department has developed three new high-temperature diodes that operate in sustained ambient temperatures up to 500°. The tubes were designed for use in a high-temperature generator regulating circuit for Mach 3 aircraft, as well as for other military aircraft and missile applications. All three tubes, which are of ceramic construction and



filled with an inert gas, are available in limited quantities for engineering samples. Their current ratings range from 0.15 amperes to 10 amperes.

Circle No. 235 on Subscriber Service Card

Preamplifier/Rejection Unit

Kearfott Division, General Precision, Inc., has available the C70 3117 001 Preamplifier and Quadrature Rejection Circuit for various military and industrial applications. Economical operation is effected by utilizing low-cost, low-gain servo amplifiers with this unit. Identical servo amplifiers can be used in either high- or low-gain servo loop designs. In servo loops requiring high gain, the C70 3117 001 unit is used with a low-gain amplifier, and where low gain is required the Quadrature Rejection Circuit (D4821-01) is used without the preamplifier.

Circle No. 236 on Subscriber Service Card

Permanent Magnet

A permanent magnet, ALNICO VIII, available from Crucible Steel Co., has over twice as much resistance to demagnetization as ALNICO V, and is substantially higher in both coercive force and maximum energy product than ALNICO VI or VII. In the past, it was impractical to use permanent magnets in many applications because of severe temperatures and other environmental conditions. ALNICO VIII now makes practical design possible.

Circle No. 237 on Subscriber Service Card

contracts

NASA

$533,000—**United Nuclear Corp.**, New York City, for design and manufacture of a 1000 kw liquid metal heat transfer loop for Lewis Research Center.

$100,000—**Boeing Co.**, Seattle, for determination of the most effective method of clustering solid-rocket boosters.

North American Aviation's Space and Information Systems Division, Downey, Calif., for two *Little Joe* space boosters. No amount disclosed.

North American Aviation's Space and Information Systems Division, Downey, Calif., from Marshall Space Flight Center, for development of mathematical techniques to provide the mechanics for satellite rendezvous. No amount disclosed.

MISCELLANEOUS

$4,000,000—**Consolidated Vacuum Corp., Bell & Howell Co./CEC subsidiary**, Rochester, N.Y., from California Institute of Technology Jet Propulsion Laboratory, for a space environmental simulator to test the ultimate design of spacecraft.

$500,000—**Sanders Associates, Inc.**, Nashua, N.H., for production of subminiature rate gyros for the North American Search and Ranging Radar system.

$102,626—**Collins Radio Co.**, Dallas, from California Institute of Technology (JPL), for installation and maintenance engineering assistance on the JPL Deep Space Instrumentation Facility, Johannesburg, South Africa.

NAVY

$6,500,000—**Westinghouse Electric Corp.**, Baltimore, for production of Mark 45 torpedoes.

$1,460,000—**Boeing Co.**, Seattle, for design and contraction of a 15-ton twin-hull hydrofoil test craft to be used as a test bed for development of "supercavitating" hydrofoils.

$99,500—**General Precision, Inc.**, Tarrytown, N.Y., from Air Development Center, Johnsville, Pa., for development of performance specifications for a data processing system and associated displays for a new manned-aircraft antisubmarine warfare application.

ARMY

$4,048,005—**Collins Radio Co.**, Dallas, for radio terminal set for use with the *Pershing* missile.

$2,900,000—**Bendix Corp.**, Detroit, for electronic equipment for the shipboard terminal of Project *Advent* communications satellite; development of satellite communication equipment, associated ground communication terminals and pre-launch satellite checkout equipment for *Advent*.

$1,251,119—**Martin Co.**, Orlando, Fla., for *Pershing* weapon system. (7 contracts.)

$1,000,000—**Cubic Corp.**, San Diego, Calif., for production of Geodetic SECOR equipment.

$828,962—**Western Electric Co.**, New York City, for *Nike* replenishment spare parts. (3 contracts.)

$532,269—**Lamtex Industries, Inc.**, Farmingdale, N.Y., for production of chemical rocket shipping and firing containers.

$366,858—**Douglas Aircraft Co.**, Santa Monica, Calif., for *Nike* replenishment spare parts. (3 contracts.)

$235,425—**Martin Co.**, Orlando, Fla., for concurrent repair parts and modification kit for *Lacrosse* missile system.

$119,324—**Martin Co.**, Orlando, Fla., for replenishment spare parts for *Lacrosse* weapon system.

AIR FORCE

$37,130,467—**IT&T's Federal Electric Corp.**, Paramus, N.J., for operation, maintenance and support of the Distant Early Warning (DEW) Line for FY 1962.

$14,980,000—**Avco's Research and Advanced Development Div.**, Wilmington, Mass., for continued development on re-entry vehicles for *Titan* and *Atlas* ICBM's;

$14,647,500—**Avco's Lycoming Div.**, Stratford, Conn., for follow-on production of re-entry vehicles, spares and associated ground support equipment.

$12,950,000—**General Dynamics/Fort Worth**, for Category I flight test of B-58.

$7,809,000—**Hercules Powder Co.**, Magna, Utah, for work on *Minuteman* third stage.

$4,861,641—**U.S. Underseas Cable Corp.**, Washington, D.C., for extension of Atlantic Missile Range cable system. (2 contracts.)

$4,500,000—**Pittsburgh-Des Moines Steel Co.**, Pittsburgh, for steel fabrication to be used in second phase of *Titan II* missile project, Wichita, Kan.

$3,400,000—**AC Spark Plug Division, General Motors**, Flint, Mich., for depot maintenance for *Thor* guidance system and related ground equipment.

$3,137,530—**Goodyear Aircraft Corp.**, Akron, Ohio, for modifications of *TM-76A Mace* missile.

$2,250,000—**Martin Co.**, Orlando, Fla., for production of the nuclear warhead *GAM-83B Bullpup* air-to-surface missile.

$1,687,128—**Ryan Aeronautical Co.**, San Diego, Calif., for production of kits, components material, services and data for *Q-2C* target drones.

$1,395,250—**Aerojet-General Corp.**, Azusa, Calif., for production of liquid-propellant rocket sled system and components.

$1,207,000—**General Electric Co.**, Syracuse, N.Y., for depot maintenance of *Atlas* guidance subsystems and ground support equipment.

$1,000,000—**General Atomic Div., General Dynamics Corp.**, San Diego, for classified research.

$1,000,000—**The Siegler Corp.**, Los Angeles, for design and installation of electronic and antenna equipment for space and satellite programs.

$725,000—**The Siegler Corp.**, Anaheim, Calif., from **The Martin Co.**, for production of video systems for operational sites of *Titan* ICBM's.

$500,000—**Fairchild Semiconductor Corp.**, Mountain View, Calif., from **Boeing Co.**, for transistors for *Minuteman* program.

$350,000—**Republic Aviation Corp.**, Farmingdale, N.Y., for development of rivets, bolts, and other mechanical fasteners which can withstand space environment.

$199,000—**University of Michigan**, Ann Arbor, for study of the transfer of heat by boiling liquid metals.

$157,226—**Colorado Research Corp.**, Broomfield, Colo., **subsidiary of Bell & Gossett Co.**, from **General Electric Co.**, for design and manufacture of microwave refractometers for a new Missile Trajectory Measurement System (MISTRAM).

$64,000—**Microwave Associates, Inc.**, Burlington, Mass., for development of microwave plasma amplifiers.

$50,000—**Westinghouse Electric Corp.**, Lima, Ohio, for a 4000-watt solar power system suitable for use in earth-orbiting satellites.

Atlantic Research Corp., Alexandria, Va., for production and flight testing of new "three-finned" version of *Iris* rocket. No amount disclosed.

Talley Industries, Inc., Phoenix, Ariz., for production of a new solid-propellant ballistic actuator for the *Titan II* missile silo program. No amount disclosed.

Oxygen Tests

(Continued from page 27)

on themselves, and reported on environmental conditions. These reports were given during 6-minute intervals every 90 minutes, simulating conditions in an earth orbiting laboratory. Other communication was strictly limited.

Work-rest cycles also were studied. The two men manned the cabin's performance panel 20 hours a day in shifts varying in length from two to five hours. Careful performance records were kept on an electronic console outside the "cabin."

The tests were conducted in SAM's Space Cabin Simulator, built by Minneapolis-Honeywell's Aeronautical Division. The manned satellite simulator is an elliptical steel tank 8 ft. high by 12 ft. long equipped with facilities like those which might be found in a space vehicle. Closed-circuit television cameras are concealed behind the control panel and the subjects are constantly observed, although they have the illusion of isolation.

The two subjects who just completed testing exhibited no antagonistic reactions to each other during the long confinement. However, they were friends of long standing, having been stationed together in Japan. Some earlier confinement tests—30 days in duration—had produced some friction between test subjects. ⁂

Predetection Recording

(Continued from page 26)

In the predetection recording method, the base line shift does not occur when speeds are reduced, since the frequency of a sine wave is merely reduced in direct proportion to the change in playback speed. No degradation of data occurs, therefore, and in addition, the low end of such a system can be d-c.

Both linearity and amplitude stability of a predetection recording system can be quite high, Tobias said. He pointed out that linearity can be within 0.1% and amplitude stability can be within 0.5% across an entire roll of tape. The excellent amplitude stability possible makes a PAM/FM or PACM/FM system feasible.

Bias and record level settings are less critical than for other types of recording systems, Tobias continued, because sine waves are recorded instead of postdetected data in square wave or pulse form.

Equipment necessary for the predetection recording setup is easily available, he said, and the entire system—consisting of receivers, detectors and re-

corders—is interconnected by BNC connectors. Setup and checkout time is approximately five minutes.

Equipment includes a receiver in which the final stage of the IF limiter output from the receiver has been heterodyned to 600 kc. Such receivers have discriminator-type detection devices built in so that on playback the IF is detected and converted to a video output signal. This type of equipment eliminates accessory discriminators unless speed reduction is required on playback, at which time a counter-type discriminator can be used. ⌗

Six Stations Will be Able To Order Mercury Re-entry

POINT ARGUELLO, CALIF.—Six of the 18 globe-girdling tracking stations supporting Project *Mercury* orbital flight will have direct voice communication with the capsule and the capability to command re-entry.

Typical of the command stations is the one located at Point Arguello on the Pacific Missile Range. If re-entry command from the Kauai Island, Hawaii, station fails, Point Arguello will be able to reset the switch for retro-rocket firing.

Main console in the PMR *Mercury* Room has three stations:

—Middle station is the capsule communicator's console, which may be manned by one of the seven astronauts. The capsule communicator will be in voice communication with the orbiting astronaut and will see displayed on his console the time of day, time elapsed since launch, remaining time for retro-rocket firing, and, at the bottom, a photograph of the control board in the capsule.

—The aeromedical console, on the communicator's left and operated by a Navy bio-science officer, will monitor the astronaut's oxygen supply, body temperature, respiration and pulse rate. In the center of this console is an electrocardiograph screen. All data is displayed on a strip chart recorder.

—The systems monitor console, on the communicator's right and manned by a member of NASA's Space Task Group, will monitor spacecraft systems operation, displaying pressure, temperature, fuel, roll, pitch and yaw.

Across the room from the main console is a plotting board and the communications technician's console for selection of transmitters and receivers during capsule-station communication.

The station's tracking and receiving equipment is located on two mountain peaks about 2000 ft. above sea level.

Other command stations are at Cape Canaveral, Bermuda, Woomera in Australia, and on Grand Canary in the Canary Islands. ⌗

when and where

JULY

Western Plant Maintenance and Engineering Show, Pan Pacific Auditorium, Los Angeles, July 18-20.

Structural Engineering Aspects of Atomic Shelter Seminar, Pennsylvania State University, University Park, July 23-Aug. 4.

Electronic Maintenance Engineering Association Exhibition and Symposium, Mayflower Hotel, Washington, D. C., July 24-26.

Differential Equations in Non-linear Mechanics, AFOSR, cosponsored with Martin's RIAS Div., Air Force Academy, Colorado Springs, Colo., July 31-Aug. 4.

Physics of the Solar System and Re-entry Dynamics, National Science Foundation, NASA, Virginia Polytechnic Institute, Blacksburg, July 31-Aug. 11.

AUGUST

Space Age Astronomy, symposium sponsored by Douglas Aircraft Co., Cal-Tech, Pasadena, Aug. 7-9.

American Rocket Society/Stanford University, Guidance and Control Conference, Stanford University, Palo Alto, Calif. (Some sessions classified), Aug. 7-9.

Society of Photographic Instrumentation Engineers, 6th Annual Technical Symposium, Ambassador Hotel, Los Angeles, Aug. 7-11.

Survival in the Nuclear Age—Executive Management Seminar, Pennsylvania State University, University Park, Aug. 13-18.

International Astronomical Union, 11th General Assembly, Pasadena, Calif., Aug. 15-24.

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Shuffleboard on the Moon

IF YOU PLAY shuffleboard, you know that scoring depends not only on getting your own weight in a good position but also in knocking your opponent off the board. It's an exciting, competitive game.

NASA's big shuffleboard game on the manned lunar program got under way last week with the industry-wide *Apollo* conference attended by representatives of some 360 firms. There were several clever maneuvers for position and some pretty good efforts at knocking the other fellow off the board. It was the kind of competition that can result in a technologically healthy program.

But let's imagine for the moment a shuffleboard game played under rather strange rules. Just as you edge past your opponent into a good position, the referee picks up your weight, puts it in his pocket, and declares, "This is mine." You would feel quite rightly that your chances of winning were being somewhat compromised.

Yet this is what NASA, in effect, is doing to a number of firms in the *Apollo* competition. Feasibility study contracts which went to the three firms in California, Maryland and Pennsylvania were quite limited financially. Little of the money filtered down to the subcontractors aligned with these three teams.

These firms gambled considerable amounts of their own capital in studies of guidance, propulsion and other aspects of the manned lunar program. The primes, including those which did and did not receive one of the three study contracts, also put their own money—quite a bit of it—into the design studies which they unveiled last week.

Some of the industry's more far-sighted firms have been at work on manned lunar systems and subsystems for several years, these company-funded programs antedating the NASA feasibility contracts and extending at times to experimental hardware.

On arrival in Washington for the *Apollo* conference, representatives of these firms found they were expected by NASA to throw all their know-how into the kitty for the "benefit" of the nation's all-out effort to beat the Russians to the moon.

Once again, proprietary rights were out the window.

It's about time something concrete was done about the question of proprietary rights. Ours presumably is a society based on economic, democratic capitalism, not communism. We count on competition among private firms to keep us ahead of the Russians. A great deal of lip-service is paid to this by prominent government officials.

Yet, on what is true competitive advantage based, if not upon know-how of the competing firms? To dispossess a company of its know-how is to take away its winning weight on the shuffleboard.

It is a fallacy to assume that this will benefit the nation in reaching its goals—a fallacy, that is, if you believe in our type of economic system. If we are going to do it the other way, let's call ourselves communistic and be done with it.

Few industry representatives question the government's right to data developed in programs that are 100% government-financed. It is in insistence on a right to this data from other programs that the difficulties arise.

NASA, with an opportunity to develop new guide lines on proprietary rights, unfortunately seems to be following the questionable policies of the Department of Defense.

Armed Services Procurement Regulation IX Part 2 contains this statement: "It is the policy of the Department of Defense to encourage inventiveness and to provide incentive, therefore, by honoring the 'proprietary data' resulting from private developments and hence to limit demands for data to that which is essential for government purposes."

Unfortunately, DOD has too sweeping a notion of what is essential for government purposes. It is disheartening to see NASA going the same route.

A NUMBER of responsible missile/space industry executives are deeply disturbed by the government's cavalier attitude toward proprietary rights.

Mr. Denham S. Scott, assistant to the president, Garrett Corp., writing in the current issue of the monthly magazine *Aircraft & Missiles*, suggests that the present impasse can only be broken by a willingness by both parties to compromise.

He suggests that all requirements for data should be a separate contractual item, with the needs and the rights clearly out in the open so each party can negotiate intelligently. Mr. Scott also points out the dangers inherent in unqualified acceptance of competitive bidding on parts which have been developed by an individual firm under government contract.

"The low bidder in a typical competitive bid is not necessarily bidding on the same thing as the designer, and the millions of dollars spent for safety and reliability are sometimes sacrificed on the altar of false economy," he writes.

For a procurement officer to snap that "If they don't like it, they don't have to stay in the business," is not a satisfactory answer. In the competition with the Soviet Union in the decade ahead, every bit of industrial skill this nation possesses must be available to the government.

Anything that threatens the enthusiasm and willingness of private firms to participate in government programs endangers our chances of survival as a nation. Missile/space industry firms are willing to gamble time and capital in programs such as *Apollo*. But they must be assured that they will not be denied the benefits of their efforts.

The *Apollo* program would be an excellent one on which to get a fresh start on the problem of proprietary rights.

William J. Coughlin



UNSEEN BUT NEVER LOST. ***Far down in the secret depths of the sea America's Polaris submarines can cruise for many weeks, poised for free world defense. Without surfacing, men of these submarines can pinpoint their exact position constantly. The equipment to perform this precise duty is called Mark II SINS (Ship's Inertial Navigation System). The first operational SINS was designed, built, and delivered in record time by Autonetics.***

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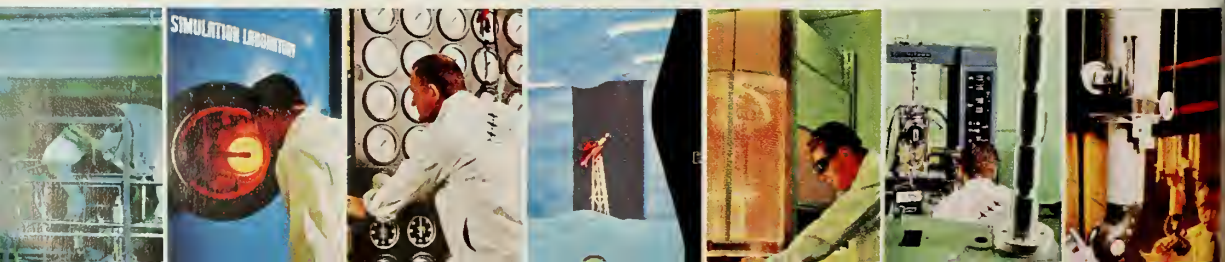


The Uses of Space

Man is the searcher. He has a driving urge to know. After centuries of speculation, we now know that the world of space is infinitely more vast even than in our dreams. How shall we rise to the challenge of space knowledge? Ask any scientist and he will tell you: space is not something to be conquered but to be used--for reconnaissance, instant world-wide TV and radio communications, weather forecasting and basic research. Where will it all end? It never will.

Shown above is one feature of Republic's Space Environment and Life Sciences Laboratory, largest space chamber in the nation capable of testing men and space systems at simulated altitudes of more than 150 miles. Republic's new Research & Development Center is the only fully integrated industrial research complex engaged in every vital area of space investigation. Eight laboratories comprise the Center: Space Environment and Life Sciences; Re-Entry Simulation; Materials Development; Nuclear Radiation; Electronics; Guidance and Control Systems; Fluid Systems; Transonic, Supersonic and Hypersonic Wind Tunnels. Behind Republic's record of military aircraft success is the idea of man as the "irreplaceable element." This same concept is the basis of Republic's wide-ranging exploration of every field of space knowledge.

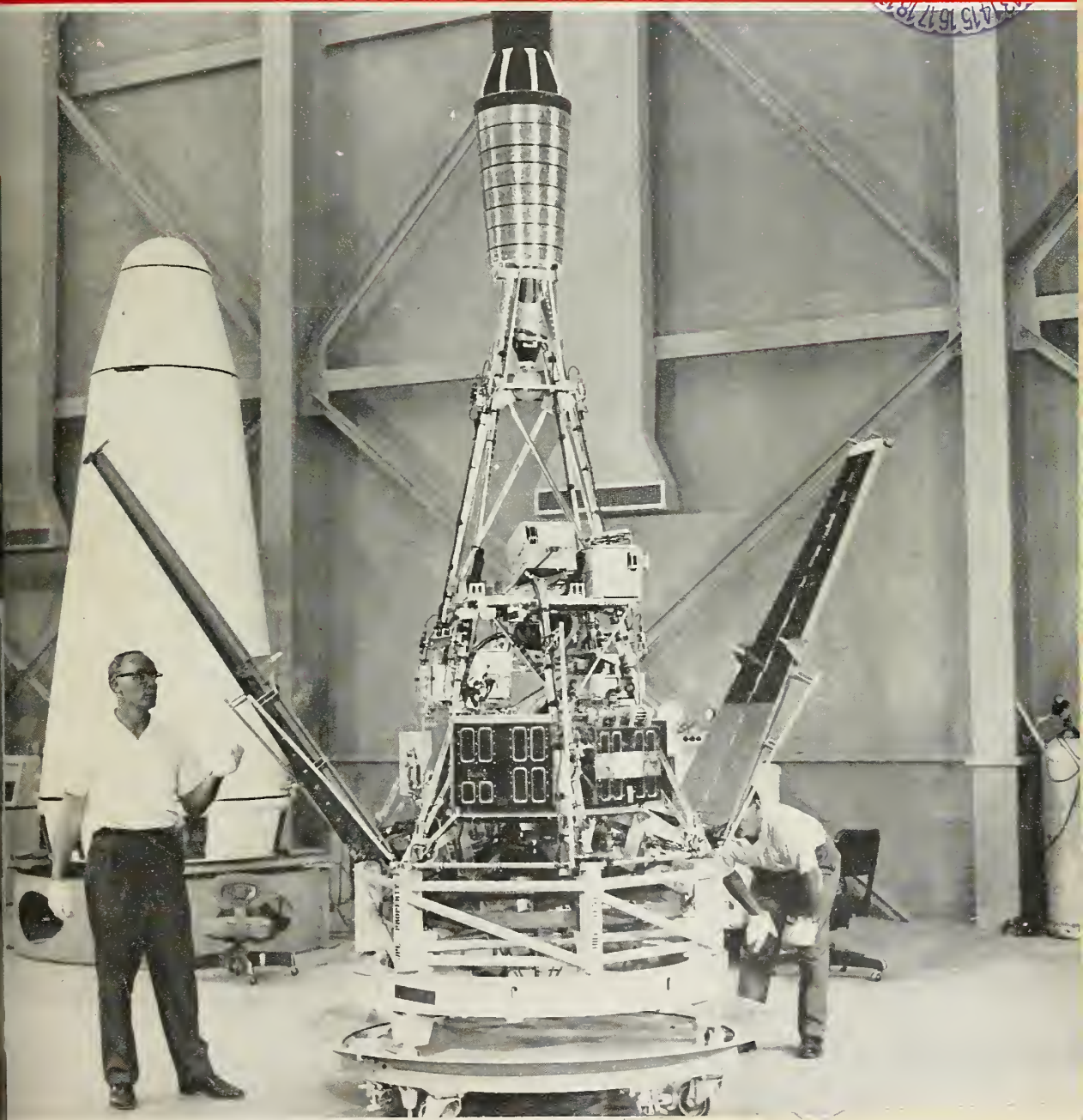
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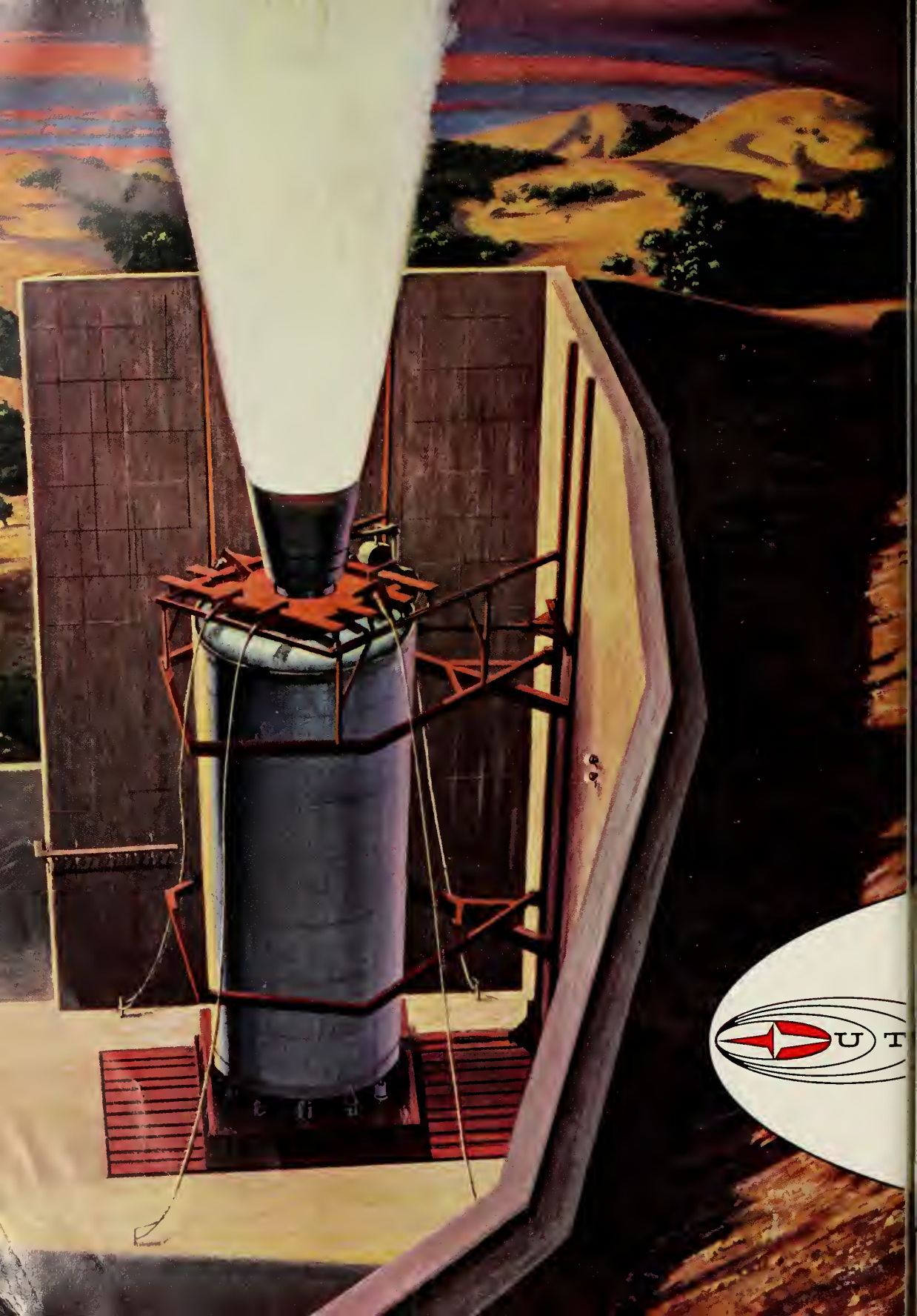
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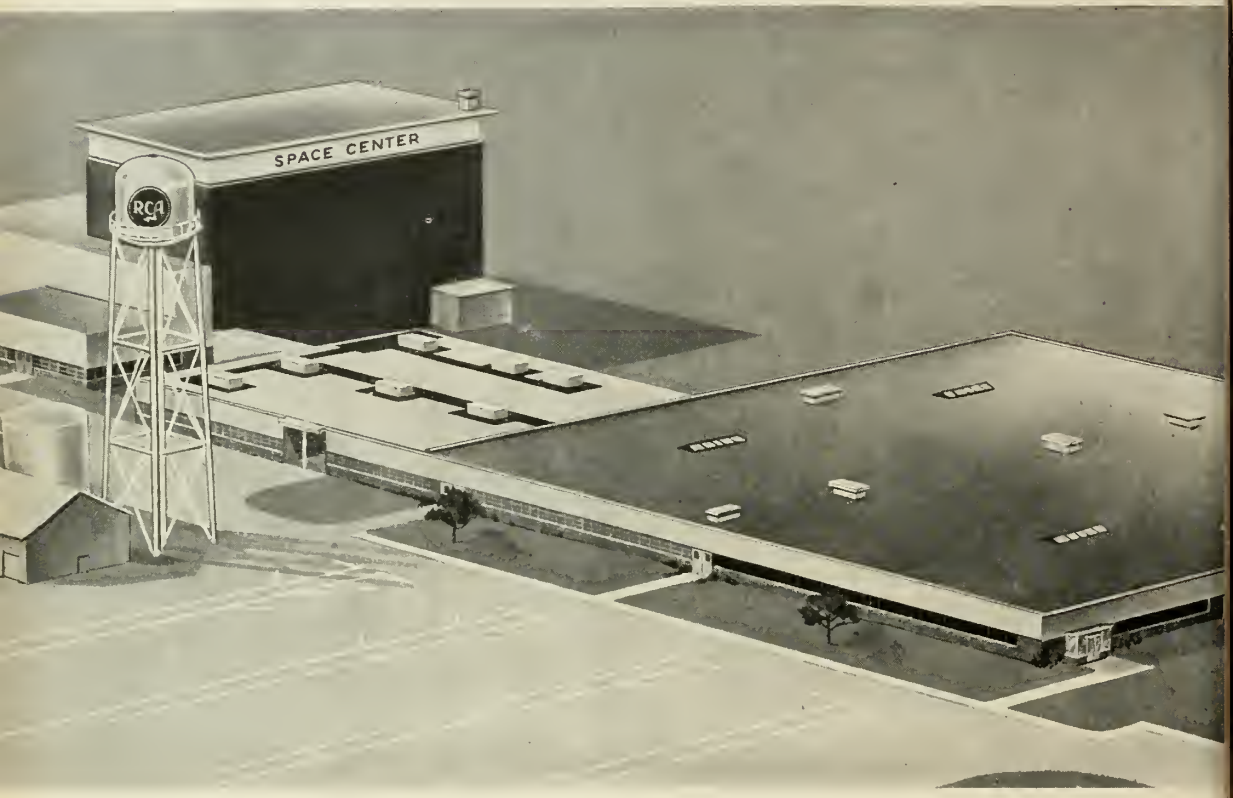
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**Excerpts from the special message delivered by President Kennedy before a joint session of Congress, May 25, 1961.*

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New RCA Space Environment Facility Brings Outer Space Down to Earth...



. . . Will pretest coming generations of U.S. space vehicles and satellites at environmental extremes assuring reliable long life operation and optimum performance.

Included in the new environmental equipment and facilities being built and installed at the RCA Astro-Electronics Division at Princeton, N.J., are the following advanced testing devices:

Vacuum-Thermal Chamber — measuring 28 feet in diameter and 25 feet high to accommodate the coming generations of space vehicles and satellites and meet all vacuum-thermal requirements.

Vibration System — provides 28,000 pounds peak force for sinusoidal, and 28,000-pound rms force for random motion testing.

Temperature-Humidity Chamber — so versatile it can create virtually any thermal-humidity condition desired. Temperatures may be varied from —85° F to 250° F; humidity from nil to maximum.

Rotary Accelerator — subjects subsystems of space vehicles and satellites to forces as high as 2500 g lbs.

The entire RCA Space Center, which contributed to the success of projects such as SCORE, TIROS I, TIROS II and ECHO I, continues to be dedicated to the conception, development and production of earth satellites, space vehicles and ground support and information handling equipment. For additional information about RCA's engineering talents and proved capabilities, contact the Manager, Marketing, RCA Space Center, Box 800, Princeton, N. J. And, for a complete description of the new environmental facilities, write for your copy of the brochure "RCA Space Environment Center."

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missiles and rockets

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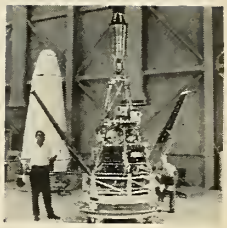
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Director of Circulation

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THE COVER

First photo of NASA's Ranger lunar impact spacecraft shows JPL technicians monitoring unfolding of solar panels. First launch was scheduled for last week. See p. 14.



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† U.S. Reg. Pdg.

35,375 copies this issue



Since the early days of "wireless" Blaw-Knox has been designing, fabricating and erecting towers and special structures to support equipment used to penetrate space. This long experience with the problems involved in this field is the reason systems companies and governmental agencies continue to utilize Blaw-Knox specialized facilities.

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letters

Someone Should Investigate

To the Editor:

This letter is in reference to Mr. (George W.) Earley's Letter to the Editor (M/R, July 17, p. 9) under the heading "UFO's Will Rise Again." I took the trouble to scan the back issues of MISSILES AND ROCKETS to find the previous (M/R, March 27, p. 6) correspondence between you and Mr. Earley. It would have been a simple job had you indicated in which issue Mr. Earley's first letter appeared. Briefly, the first letter asks M/R to investigate the accusation that the USAF is withholding information concerning UFO's. The National Investigations Committee on Aerial Phenomena (NICAP) is recommended as a convenient source of information. Your comment: "What else is new in Bloomfield?" I don't know if this is supposed to be humorous, derisive, or what? Anyway, Mr. Earley, in his second letter, raised the question as to your sincerity in wanting the American people to be thoroughly informed. Your handling of this question certainly nourishes his and my doubts on the issue. NICAP has in its possession numerous UFO reports given by highly qualified observers, which when reviewed provide a convincing argument for existence of UFO's. I believe the matter is serious enough to warrant an investigation.

Nicholas Conigliaro
Hazlet, N. J.

M/R is a trade journal of the missile/space industry. Our working time and pages are necessarily devoted to covering the multitude of known, factual events and trends in that industry. We take no sides in the UFO debate; we just don't have time for it.—Ed.

Ski-Launches and Patents

To the Editor:

Two subjects:

(1) On May 29, before (syndicated columnist) Ralph McGill reported the ski-slide launching system for Russian missiles, I wrote to your editorial department suggesting that you get and publish full details on the French report which was the subject to McGill's column. I feel that most of your subscribers, like myself, were keenly interested, and disappointed also when issue after issue of M/R came out minus any word on that reported launching system. You could at least have denied the truth of that report if it were false, or acknowledged my letter.

(2) Your July 24 editorial relative to patent rights on inventions flowing out of U.S. R&D contracts:

If you regularly read *Electronics*, you may have seen my letter commenting on this subject, also some further comments by others.

The crux of this doubletalk by our large R&D contractors is that they themselves do not practice what they preach. When *they* hire scientists and engineers they demand and get employment contracts which give *them* all of the inventions of these employees in which they have the slightest present or possible future interest.

But, when these same R&D contractors are hired by the government they demand, unjustifiably, the outcoming patent rights! And you, as does McGraw-Hill, loyally support the sources of *your* revenue!

I'd like you to *print* this, please.

Benjamin F. Miessner
Fellow IRE and ASA
Miami Shores, Fla.

(1) For more than a year there have been rumors that the Russians have been launching missiles from carriages traveling rails laid down one mountain slope into a valley and up a second mountain slope. According to these reports, the booster ignites when the carriage nears the end of the track and the missile goes into its trajectory greatly assisted by the momentum gained during its "rollercoaster" trip. M/R has not published these rumors (nor, we believe, has any other technical publication) because of the obvious technical objections to any such launching technique. Perhaps the most apparent flaw would be the sloshing problem; sloshing poses difficulties even in vertical launchings —in any such angled take-off they would be fantastic.

(2) The editorial concerned private *developments by missile/space firms. Inventions by employees on company time would hardly seem analogous.—Ed.*

Appreciated

To the Editor

We have an active interest in educating the youth of our community in space technology through our Speakers Bureau activities, and have been aided in many ways by utilizing the information contained in M/R's Astrolog.

I have also reviewed your World Missile/Space Encyclopedia (M/R, July 17) and find this information very useful.

Thank you for such a fine publication.

R. A. Scheffer
Senior Engineer
Electrical Space Propulsion
General Electric Co.
Cincinnati

Redstone Interest

To the Editor:

"Redstone's Years of Frustration" by James Baar (M/R, May 15, p. 17) is a very fine article that is of interest to all in the *Redstone* program.

John R. Riordan
Major, Artillery
Chief
U. S. Army Artillery and Missile School
Guided Missile Department
Redstone Division
Fort Sill, Okla.

—mergers & expansions—

LABORATORY FOR ELECTRONICS, INC., and Tracerlabs, Inc., boards of directors have voted to merge the two companies, pending stockholder approval. Laboratory for Electronics will be the surviving company. LFE is a producer of airborne navigation and radar systems, microwave test instruments, data storage, and display equipment. The combined companies will have sales of over $60 million.

UNITED RESEARCH INCORPORATED and Broadview Research Corp. have merged, with BRC now a wholly owned subsidiary of URI. The parent company performs R&D in physical sciences, management sciences and data processing.

ASTROPOWER, INC., is planning to build an R&D center at Costa Mesa, Calif., to house engineering, laboratory and administration facilities. Occupancy is scheduled for next May. The company will also build a rocket propulsion test site at Gypsum Canyon, Calif., to test small-scale propulsion units and other space vehicle systems. The facility is expected to be operational in August.

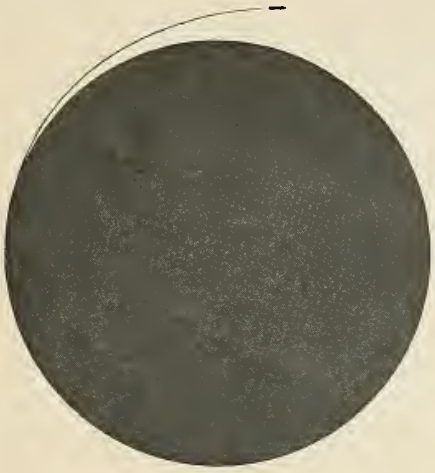
COLLINS RADIO CO's Western Operation has moved into a multi-million-dollar communication and data processing R&D facility at Newport Beach, Calif. Among the Information Science Center's projects are data transmission systems for both the Atlantic and Pacific Missile Ranges.

HEWLETT-PACKARD CO. is expanding its European operations with construction of a new plant in Western Germany and the leasing of a manufacturing facility in England. The British facility will be operated by Hewlett-Packard Ltd., a newly formed subsidiary. The German plant will be located near Stuttgart. H-P produces precision instruments and accessory devices.

ALLIED CHEMICAL CORPORATION, Nitrogen Div., announced plans for a plant to double its nitrogen tetroxide capacity. A facility for producing the rocket fuel oxidizer is being built at Hopewell, Va., and the company expects delivers to begin in late August.

PALL CORPORATION, Glen Cove, N.Y., has merged with Trinity Equipment Corp., a producer of dry air and gas systems, thermowells and thermocouples. Trinity will continue as a wholly owned subsidiary of Pall.

CALLERY PROPELLANT BRIEFS



Let's talk impulse in space

Exotic chemical propellants will often find their most useful applications in upper stages, for course or orbit correction and lunar landing or take-off. Isp values compared at $P_E = 0.2$ psia have a different relationship than when compared at $P_E = 14.7$ psia. Such an approximation of "space" conditions gives a much truer picture of the relative performance of propellant systems. We present (from Callery's new booklet — Propellant Performance Data*) a few excerpts to illustrate the point. As the U. S. standardizes on LOX-RP, LOX-LH_2, and solids, there is still considerable merit in storable liquid systems for specialized jobs in space.

PROPELLANT SYSTEM	SPECIFIC IMPULSE	
	Sea Level 1000→14.7	Space 1000→0.2
H_2–O_2	391	470
B_5H_9–OF_2	367	466
B_5H_9–F_2	360	460
N_2H_4–F_2	363	436
B_5H_9–O_2	327	421
B_5H_9–NF_3	326	412
B_5H_9–H_2O_2	316	405
B_5H_9–N_2O_4	306	391
B_5H_9–ClO_3F	306	390
RP–O_2	300	379
B_5H_9–ClF_3	290	368
N_2H_4–N_2O_4	291	354
CH_2–NO_2ClO_4	278	349

*Available upon letterhead request from:

Callery Chemical Company, Defense Products Department

Headquarters: Callery, Pennsylvania, Telephone Evans City (Pa.) 3510
West Coast: 15537 Lanark Street, Van Nuys, California, Telephone STate 1-5761
Washington, D.C.: 709 DuPont Circle Building, Telephone ADams 4-4200
Dayton, Ohio, Suite 12, 2600 Far Hills Avenue, Telephone AXminister 8-1242

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missiles and rockets
4th Annual

ground support equipment issue

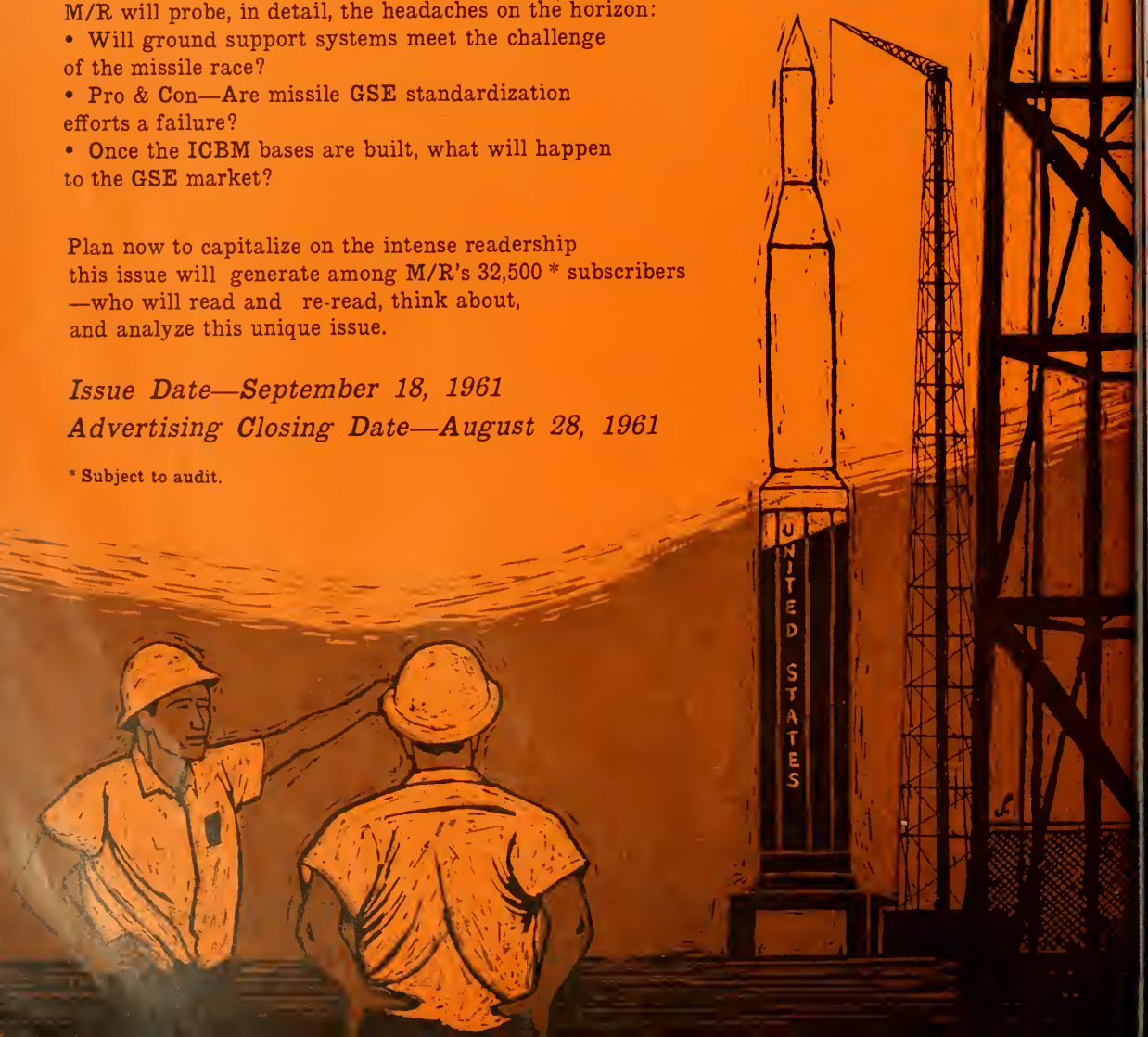
Articles in the 4th Annual **GSE** Issue will examine developments, problems and requirements of the missile/space support equipment market from 1961 to 1971.
M/R will probe, in detail, the headaches on the horizon:

- Will ground support systems meet the challenge of the missile race?
- Pro & Con—Are missile **GSE** standardization efforts a failure?
- Once the ICBM bases are built, what will happen to the **GSE** market?

Plan now to capitalize on the intense readership this issue will generate among M/R's 32,500 * subscribers —who will read and re-read, think about, and analyze this unique issue.

Issue Date—September 18, 1961
Advertising Closing Date—August 28, 1961

* Subject to audit.



The Countdown

WASHINGTON

On Spending Defense Rubles

Government experts are watching for signs that Russia will carry out Khrushchev's announced increase in Soviet military spending. When translated into purchasing power and hidden expenses, the boost runs from $8-$15 billion, depending on which expert's figures are used. If Russia is to spend this kind of extra money on defense, sharp changes in the Soviet economy are in order.

Unhappy Congressmen in Space

Despite easy passage of the re-revised $1.7-billion NASA authorization bill, a number of influential congressmen are uneasy about the nation's man-to-the-moon program. The general complaint: because of the complexity of space technology, many congressmen feel that they have to accept from the Administration's experts what they are told—even when what they are told varies from month to month.

Doubt Cast on Red Polaris Claim

Navy officials are giving little credence to Soviet claims that they possess a larger number of nuclear-powered submarines capable of launching *Polaris*-type missiles than does the United States. However, it is considered quite possible that the Soviet Union does have in operation a number of nuclear-powered submarines capable of launching relatively short-range missiles.

Wanted: Tactical Nuclear Missiles

Even with President Kennedy's call for more conventional forces, a number of Army strategists feel that the Berlin crisis underlines the need for large numbers of small, sub-kiloton-warhead missiles. HE warheads on tactical missiles will have a hard time stopping the Red Horde. But implicit in the argument for better tactical nuclear warheads is the need to resume testing them underground—as many officials feel the Russians already have done.

Coming: The Standardized Warship?

Pressure is on in the Navy—beginning with Secretary John Connally—for far greater standardization of warships and their equipment. Navy officials are arguing that it is better to have a lot of one good model than just a few of several different models. For example: A missile frigate in FY 1959 was estimated to cost $48.7 million; a missile frigate in FY 1961 was estimated to cost $71 million.

Mercury Check and Double Check

Tough orders have gone out from NASA to Cape Canaveral technicians for the most minute checkout to date of the *Atlas* that will attempt to hurl a *Mercury* capsule into orbit this September. Two out of three *Atlas* launchings in the *Mercury* program have failed in the past. Another failure in September would be certain to push the first attempt to orbit a manned capsule far into next year.

INDUSTRY

Jobs . . . Jobs . . . Jobs

NASA soon expects to have 135 top job openings for scientists and executives. Seventeen of the jobs will pay up to $21,000 a year . . . the rest up to $19,000. NASA officials say some of the new posts will be filled from within the agency, but most will be filled from industry. The Manned Space Flight Group has 78 of the openings —28 will be in existing programs; 10 will be in advanced research; 10 in nuclear propulsion work; 10 in NASA headquarters.

DOD Will Be Watching

The Pentagon is putting together performance charts on contractors, for use in making future contract awards. The charts will reflect a wide variety of factors from meeting major milestones to undercutting minor cost estimates.

Sea-Launch Revived

The House Space Committee will take another look at proposals for mobile sea-launch facilities for large rocket boosters. Although it issued a report after hearings earlier this year which said there was no urgent need for such facilities, the committee now has decided to hold additional hearings—apparently to see what sea-launch could do to expedite the lunar program.

INTERNATIONAL

Sweden Eyes Satellite

Sweden's Committee for Space Research is proposing an air-launched satellite weighing 10 lbs. A Saab Draken fighter would carry a three-stage rocket to altitude, which would then fire the satellite into a 1000-mile polar orbit. So far, however, there's no sign the committee will receive the $15 million needed for the project.

Vulcan-Skybolt Compatibility

Douglas *Skybolt* ALBM's reportedly have passed electromagnetic compatibility tests with British Vulcan bombers. A problem of matching *Skybolt's* electronic gear to the Vulcan's navigation system appears to have been solved.

Overseas Pipeline

About 70 Sud Aviation *SE 4280* tactical missiles are now operational with the French Army. . . . Elliott-Automation Ltd. and C. A. Parsons & Co. Ltd. have joined the British Space Development Co.—making a total of 11 firms now in the space research enterprise. . . . France's Military Mission has been in contact recently with The Martin Co., discussing possible purchase of the 400-mile *Pershing*.

The Missile/Space Week

Shots of the Week

The Army successfully fired its *Pershing* missile from Cape Canaveral July 19. ABMA reported that preliminary data indicated all test objectives were achieved. Exact distance was not disclosed, but an ABMA official said the missile exceeded the maximum range of the *Redstone*, which *Pershing* will replace.

A *Discoverer* satellite, the 27th in the series, was destroyed by the range safety officer 60 seconds after launching from Vandenberg AFB July 21. Air Force officials had no immediate explanation for the failure.

A Canaveral-launched *Titan* went 5000 miles down the Atlantic Missile Range July 25, guided for the first time by "Achiever." The guidance system is a self-contained inertial package containing a 90-lb. computer, with a 57-track magnetic memory drum.

Fly-by Speed-up Studied

The launching of a Mars "fly-by" may be updated two years, from 1964 to late '62.

The National Aeronautics and Space Administration is studying whether it is too late to reschedule the Mars probe, planned originally for 1962 but delayed for 25 months because of budget restrictions. Budget curbs have now been lifted and if it is possible to update launch time, House Space Committee Chairman Overton Brooks considers it a chance to reclaim some of the prestige lost when Russia put the first man into space.

Tiros III Loses One Camera

One of the television cameras aboard *Tiros III* has gone out of action, but a duplicate is still taking high-quality cloud cover pictures.

NASA said the failure was detected July 24, after the 170th orbit and after the camera had taken 2020 "excellent quality" cloud cover pictures.

The cause of failure has not been determined and scientists do not know if it is a permanent malfunction. Since two wide-angle cameras were aboard, NASA said, the loss of one will not affect the satellite's useful lifetime.

Aerojet to Develop NERVA

Aerojet-General Corp. has been awarded a $6-million, first-phase contract for development of the nuclear rocket engine, NERVA.

The six-month contract will include design of the engine, which is being built under a joint NASA-AEC program. NERVA is the first-generation nuclear powerplant which will lift heavy payloads on interplanetary missions.

Space Environment for NASA

NASA has awarded a contract to the Minneapolis-Honeywell Regulator Co. for design and engineering services of a space environment facility.

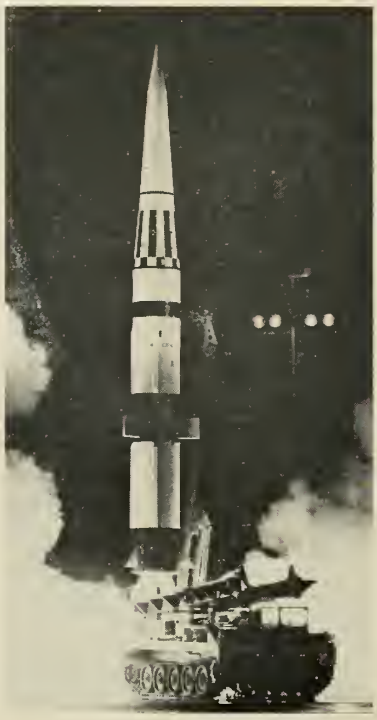
The laboratory will be built at Greenbelt, Md., and will be used to check out and test large spacecraft.

The firm was one of seven industrial companies which submitted bids.

Two space chambers—among the largest to be constructed in the nation—will measure 35 ft. in diameter and 52 ft. high. Working dimensions internally will be 30 ft. by 40 ft.

The chambers are due to be in operation on Oct. 31, 1962.

A dynamic test chamber will test mechanical actions—dynamic balancing, spinup tests, and solar paddle erection—which normally occur under near-vacuum conditions and which cannot properly be simulated under ground atmosphere conditions.



Successful Pershing

ALL TEST AIMS were achieved in recent test firing of the Army's Pershing missile from Cape Canaveral. Objectives included further evaluation of the missile's self-contained inertial guidance system and high-performance rocket motors.

Yuri's Cuban 'Dream'

A driving rain and a large crowd greeted Yuri Gagarin on his arrival in Havana to help celebrate the eighth anniversary of Fidel Castro's revolution.

The Soviet astronaut received a hero's welcome and told the Cuban people he was "very happy that my old and cherished dream is at last coming true—to visit heroic Cuba."

NASA Gets Extra Funds

President Kennedy signed NASA's Fiscal 1962 appropriations bill providing a total of $1,784,300,000.

He had asked Congress for extra money on May 25, when he committed the U.S. to a "leading role in space achievement" and to putting a man on the moon by 1970. Kennedy signed the bill several hours after watching the sub-orbital shot of Astronaut Virgil Grissom.

Commission Cracks Down

The Missile Sites Labor Commission handed down its first decision since being formed in May by President Kennedy.

The case involved a jurisdictional dispute between Evans Construction Co. and International Telephone &

Telegraph Corp. over work assignments in the installation of underground cable at Walker AFB, N.M., missile site. There was no work stoppage and all parties complied with the decision.

Meanwhile, the Commission issued a four-page policy statement saying it would crack down on wasteful practices or overtime pay abuses by unions at missile bases and would check contracts covering construction at bases to try to end "unreasonable" provisions.

Highlights:

—Wages and fringe benefits should not cost more at missile sites than at other construction activities in the same locale.

—"The Commission has directed its attention particularly to the pyramiding of premium pay, to excessive travel and subsistence allowances and to unusual premiums for various types of work operations."

—"The Commission urges the Defense Department and NASA to review the present schedules of overtime hours on bases."

—Affected parties will have an opportunity to present their views before the Commission condemns any provisions as unfair.

Minuteman Award to Hercules

A $50-million Air Force R&D contract was awarded to Hercules Powder Co. for *Minuteman* third-stage propulsion. The contract also calls for delivery of several flight-test motors for the solid rocket to Cape Canaveral.

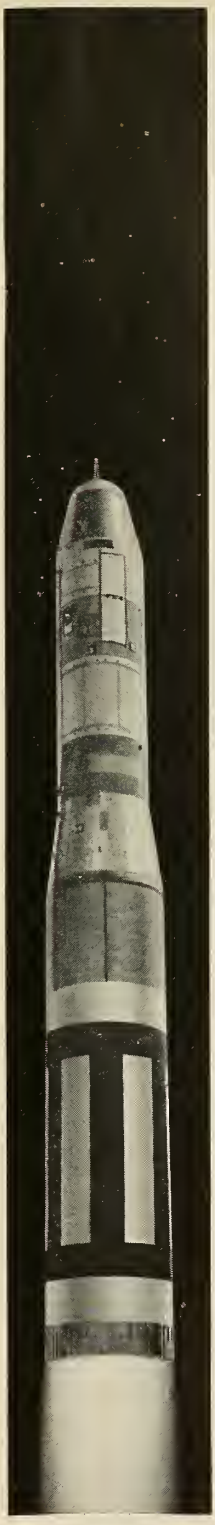
Work will be conducted at Hercules' Bacchus, Utah, plant with support from other divisions.

Flight Records Recognized

Space flight records claimed by both the USSR's Yuri Gagarin and the U.S.'s Alan Shepard have been officially recognized by the IAF (Fédération Aeronautique Internationale), the international authority on flight records.

Gagarin: duration in orbital flight —108 minutes; greatest altitude in earth orbital flight—203 miles; greatest mass lifted in earth orbital flight —10,395 lbs.

Shepard: altitude without orbit—115.696 miles; greatest mass lifted without earth orbit—4031.7 lbs.



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New Defense Plans Call fo

Congress due to give quick approval to Kennedy request for another $3.4 billion—$357.8 million for missiles

by James Baar

THE BERLIN-PROMPTED third revision of the Kennedy defense budget is initiating a major build-up of the nation's long-neglected tactical missile arsenal.

Moreover, the $3.4-billion increase in the Administration's defense requests for FY '62 is making the need for the build-up more critical than ever before —by creating new divisions to equip.

These are but two of the significant factors involved in or expected to result from President Kennedy's dramatic call for increasing U.S. limited war forces. Others:

—Many of the increases are coming too late to have other than a psychological effect in East-West negotiations over Berlin this fall. However, the increases are expected to become a permanent part of the nation's military posture in order to cope with future Berlins.

—Congress, which is expected to act quickly and favorably on the Kennedy requests, now is also all but certain to approve some three quarters of a billion dollars extra for bomber procurement and B-70 R&D despite Administration objections.

—Congressional and military pressure is expected to mount rapidly for procurement of more long-range strategic missiles, the production of the *Nike-Zeus* anti-ICBM ICBM and a far greater increases in ASW forces, particularly in hunter-killer nuclear-powered submarines.

—The requested increases for tactical missile procurement, $357.8 million, brought to more than $12.5 billion the total Kennedy missile/space budget for FY '62. That is about 14% of the total national budget.

The new Kennedy requests fell almost equally into two major parts. He sought $1.4 billion for more troops and for operation and maintenance. He sought $1.7 billion for the procurement of military hardware. The remaining $207 million was sought for the Pentagon's new civil defense operations.

• **Missile breakdown**—The bulk of the money for missile procurement—$262 million—was sought for the Navy. The money would be used for large increases in the purchase of air-to-surface *Bullpups*, air-to-air *Sparrows* and *Sidewinders* and surface-to-air *Talos*, *Tartar* and *Terrier* missiles.

The Navy also would receive an unspecified amount for sizeable increases in the purchase of ASW ordnance, sonobuoys and other equipment.

The second largest amount of missile money—$62 million—would go to the Air Force. The money would be used for purchase of *Sidewinders*, *Bullpups* and air-to-air *Falcons*, as well as other tactical missiles.

The Army would receive $33.8 million for missile procurement. Of this, $14.6 million would be spent on surface-to-air *Hawks* and high-explosive warheads for *Nike-Hercules* batteries. The remaining $19.2 million would be spent on *Honest John* surface-to-surface missiles and high-explosive *Honest John* warheads.

The three services would receive $558.7 million for the procurement of tactical aircraft—from helicopters to supersonic interceptors. They also would receive about $800 million for the purchase of other ammunition and equipment.

• **Swelling manpower** — The requests were considered impressive, particularly in comparison with limited war requests in recent years. However, even more impressive were the Administration's requests for increasing the size of the nation's ground and sea forces.

A total of 225,000 men would be added to the Armed Forces bringing the total number of men in uniform to 2,743,000. The Army would be increased from 875,000 to 1 million men.

Defense Secretary Robert McNamara told the Senate Defense Appropriations Subcommittee, in submitting the new budget requests less than 24 hours after Kennedy announced them, that the Army would be increased from 14 to 17 divisions.

Even more important, McNamara said that the number of combat-ready divisions in the United States would be increased from three to six, and that divisions overseas would be strengthened.

Finally, the level of readiness of Army reserves in the United States will be increased.

• **Only beginning**—Officials already have made clear that these moves are not being planned as an answer to Berlin alone but as an overall increase in the nation's ground forces for the years ahead. This can only mean a much larger build-up of stockpiles of tactical missiles and other equipment—or even greater shortages than the Army has been experiencing.

For years the Army has sought and been rebuffed in its pleas for sufficient modern equipment for its 14 divisions, a number of which are under strength. Procurement requests for new missiles, tanks, rifles and other equipment have consistently been cut. The shortages that have developed can not be eliminated by the new Kennedy increase alone.

Therefore, the Kennedy requests are considered to be only a beginning in a move to re-establish the nation's ground forces as a major factor in deterring Communist trouble-making around the world. Much larger appropriations will be needed in the next few years to complete the job.

Such increases—along with others to enlarge U.S. strategic striking forces and develop advanced missiles, aircraft and space weapons—could easily push the defense budget to nearly $50 billion in FY '63.

In fact, with the new increases, the defense budget would not have too far to go. Kennedy's additional $3.4 billion brought the total military appropriations sought for FY '62 to $46.2 billion.

That is more than $5 billion over the

oost in Tactical Missiles

New Obligational Authority in billions

	Eisenhower Budget	Kennedy Revises 1-2	Kennedy 3rd Revise	Total Changes
ARMY	10.5	10.3	11.8	1.3
NAVY	12.2	13.5	14.5	2.3
AIR FORCE	17.8	17.7	18.3	0.5
OSD	1.3	1.3	1.5	.2
TOTAL	40.9	42.9	46.2	5.3

amount sought by President Eisenhower in his lame duck defense budget last January. It is some $2 billion more than Kennedy indicated would be needed during the presidential election campaign.

• **Deliberate speed** — However, despite his campaign charges that the Republican Administration had allowed the nation's military strength to deteriorate, Kennedy did not reach the point of seeking sizeable increases swiftly.

His first revision of the defense budget in February and his second in late March made some adjustments and sizeably increased the number of *Polaris* submarines under construction. Otherwise there were no major additions.

Only this month, when confronted with the growing belligerence of the Soviets and new multibillion-dollar increases in Soviet defense spending, did Kennedy move.

"The immediate threat to free men is in West Berlin," he told a nationwide TV and radio audience July 25. "But that isolated outpost is not an isolated problem.

"The threat is world-wide. Our effort must be equally wide and strong."

Then he outlined the steps he proposed to take to meet this threat. And he solemnly warned the Soviets:

"We do not want to fight—but we have fought before. . . . Three times in my lifetime our country and Europe have been involved in major wars. In each case serious misjudgments were made on both sides of the intentions of others which brought about great devastation."

• **Expanding alternatives** — A key theme that ran through Kennedy's speech and that formed the basis of much of what he proposed to do was the need for broadening the choice of military and diplomatic response that he possessed as Commander in Chief. It was recognition that, by seeking something close to a minimum strategic deterrent, the United States had to a great extent vitiated the Soviets' belief that the strategic bludgeon would ever be used—except to retaliate against an all-out attack on North America.

By building up the Army Kennedy made clear that he was trying to develop a new deterrent—to meet the Communists with conventional weapons if necessary.

". . . I must emphasize again that the choice is not merely between resistance and retreat, between atomic holocaust and surrender."

McNamara echoed the theme the next day before the Senate Subcommittee. He said:

"We need to expand the range of military alternatives available to the President in meeting the kind of situation which may confront us in maintaining our position in Berlin."

However, McNamara also added pointedly:

"I want to make clear . . . that this does not mean we are lessening the effectiveness of our tactical nuclear capabilities."

• **Is it enough?**—Many Army officials would add that it is a good thing—and that the United States had better strengthen them rapidly.

Few military men would argue seriously that NATO could outfight the Red Army in the heart of Europe today without the use of tactical nuclear weapons. Nor would the addition of several more divisions to NATO be sufficine to make a return to conventional weapons possible.

For this reason, some Army strategists felt that Kennedy's new budget requests did not go far enough in that they made no provision for buying more tactical nuclear missiles such as *Pershing, Sergeant* and *Davy Crockett*. Moreover, there was disappointment that the President did not press ahead with the resumption of underground nuclear testing so that tactical nuclear missiles might be greatly improved.

Their argument received support earlier this month in Moscow. Russia announced the reorganization of the Red Army into small, independent rocket units designed to fight nuclear wars. ⁂

PROCUREMENT INCREASES
(In Millions)

	Missiles	Aircraft	Other	Total
ARMY	33.8	36.7	481.5	552
NAVY	262	281	166	709
AIR FORCE	62	241	122	425

Ranger I Is Most Sophisticated U.S

NASA discloses details of lunar craft designed to go into orbit atop Agena B with eight new experiments

THE UNITED STATES prepared last week to put the *Ranger I* lunar spacecraft through its first flight test in space.

In anticipation of the shot—the first NASA use of an *Atlas Agena B*—NASA lifted the lid of secrecy it had kept battened over *Ranger's* instrumentation.

Besides "road-testing" the reliability of the spacecraft, the shot was intended to check out such new equipment as an attitude stabilization system based on celestial reference, a high-gain pointable antenna, an advance communication system, the development of new components able to operate for long periods in space environment, and calibration of solar cells in a space environment.

Eight new scientific experiments were aboard the hexagonal *Ranger*. Most were to study the nature and activity of cosmic rays, magnetic fields, and radiation and dust particles in space. One will seek an answer to the question of whether the earth carries along with it a comet-like tail of hydrogen gas.

Ranger I, for which Jet Propulsion Laboratory is prime contractor, was not designed to hit the moon. It was to be launched into a long trajectory which will eventually place it in a highly eccentric earth orbit with an apogee of 685,000 miles and a perigee of 37,500 miles.

This orbit would allow it to burn up in the earth's atmosphere after a round trip of perhaps 50 days. There was a possibility that if the rocket malfunctioned slightly *Ranger I* would reach escape velocity and speed into an orbit around the sun.

• **Last word**—*Ranger I* is America's most advanced spacecraft. It is slightly more than 5 ft. in diameter at the base of the hexagon and 11 ft. long. In its cruise position, with its solar panels extended to collect energy from the sun, it is 17 ft. in span and 13 ft. wide. It weighs 675 lbs., of which 243 lbs. is electronic equipment, 144 lbs. is scientific experiments, 50 lbs. is solar panels, and 238 lbs. is its structure.

Rising from the hexagonal base are four struts and four diagonal braces made of aluminum which support scientific instrumentation. The spacecraft has two radio transmitters and two antennas, one an onmidirectional antenna at the front end and the second a high-gain directional antenna, 4 ft. in diameter, at the base of the spacecraft. The latter will be aimed at the earth in order to permit more efficient transmission of data after *Ranger* is out in space.

The solar panels are each approximately 10 sq. ft. Each contains 4340 solar cells to collect sun energy. They are expected to pick up enough solar energy to be converted into a minimum of 155 watts and a maximum of 210 watts.

In the hollowed-out inner section of the hexagon is a 125-lb. silver-zinc battery with a capacity of 9000 watt hours. This will run the spacecraft prior to the use of the solar panels. It will provide enough electrical power to run the spacecraft for two days.

Before solar power is available, the two radio transmitters on board will both start sending data to earth via the omnidirectional antenna. A three-watt transmitter will send on a frequency near 960 megacycles and a separate quarter-watt transmitter will send on a similar frequency. The quarter-watt transmitter has a lifetime of seven days.

• **Controller** — Perhaps the most sophisticated piece of equipment on board is the electronic controller which allows *Ranger* to calculate when it should perform its various functions.

It is an electronic solid-state timer which takes 400 cycles per second from the spacecraft power source, divides it into one pulse per second, and uses these pulses as the basic timing reference.

These pulses are accumulated in a storage device. The unit also contains a memory device which has a preset series of triggers. When the accumulated pulses per second match the preset count stored in the memory device, a relay is closed and the controller issues a command for *Ranger* to perform some specific function. From launch to the end of its useful life there are 10 such commands that the controller must issue; hence there are 10 such channels and 10 relays.

The controller is started three minutes before launch. After launch it serves as the reference point for future commands to be issued by the controller.

• **Liftoff to trajectory**—The *Ranger I* spacecraft will be lifted from Cape Canaveral by an *Atlas Agena B* booster with a thrust at sea level of about 360,000 lbs.

All engines of the *Atlas*—booster, sustainer and vernier—are burning at liftoff. The booster is programed to burn approximately 2½ minutes, the sustainer about 4½ minutes and the verniers about 5 minutes. At *Atlas* burnout the vehicle should be about 80 miles high and some 350 miles down the Atlantic Missile Range.

At this point, the *Agena B* separates from the *Atlas*, fires for the first time and burns for almost 2½ minutes to reach an earth-orbit speed of approximately 18,000 miles per hour. After 2½ minutes of burning time, *Agena B* shuts down and coasts in a parking orbit for more than 13 minutes, until it reaches the optimum point in its orbit to fire for the second time.

Injection of the *Agena B* and the *Ranger I* spacecraft, still as one unit, occurs approximately over Ascension Island in the South Atlantic Ocean 23 minutes after launch.

A little more than 2 minutes after injection, *Ranger I* is separated from *Agena B*. After this occurs, *Agena B* does a 180-degree yaw, fires up some solid retrorockets and moves into a different and lower trajectory from that attained by *Ranger I*. The spacecraft is now pointed on a trajectory which will take it on a long swing away from earth.

• **By the numbers**—The sequence of commands given by the controller provides a complete description of the operations of *Ranger I* on its long journey into space.

—First Command—This is issued 25 minutes after the controller was started (three minutes before launch time). This command is to the big silver-zinc battery to increase the power being sent to the larger transmitter from 1.5 watts to 3 watts.

—Second Command—This is issued at 35 minutes and turns on the scientific instruments not turned on during the passage to the critical altitude area at between 150,000 and 250,000 ft.

—Third Command—This is issued at 36 minutes and extends, by means of a compressed spring, the electrostatic

Spacecraft

analyzer package in a small box on a boom about four feet from the main body of the spacecraft. This enables the two sensors in the analyzer to look at the sun and away from the sun at the same time. The same command displaces two pins which moves the solar panels out.

—Fourth Command—This occurs at 61 minutes, 40 seconds and takes place while *Ranger I* is still staggering through space from the shock caused by separation from *Agena B*. This command turns on the attitude control system and sends power to the sun sensors, the cold gas jets, and the gyroscopes.

The sun sensors, working on the valves controlling the gas jets, jockey the spacecraft about until its long axis is pointed at the sun.

Once it is locked on the sun, the power system, recognizing that it is getting electric power from the solar panels through the converters, switches off the large zinc battery.

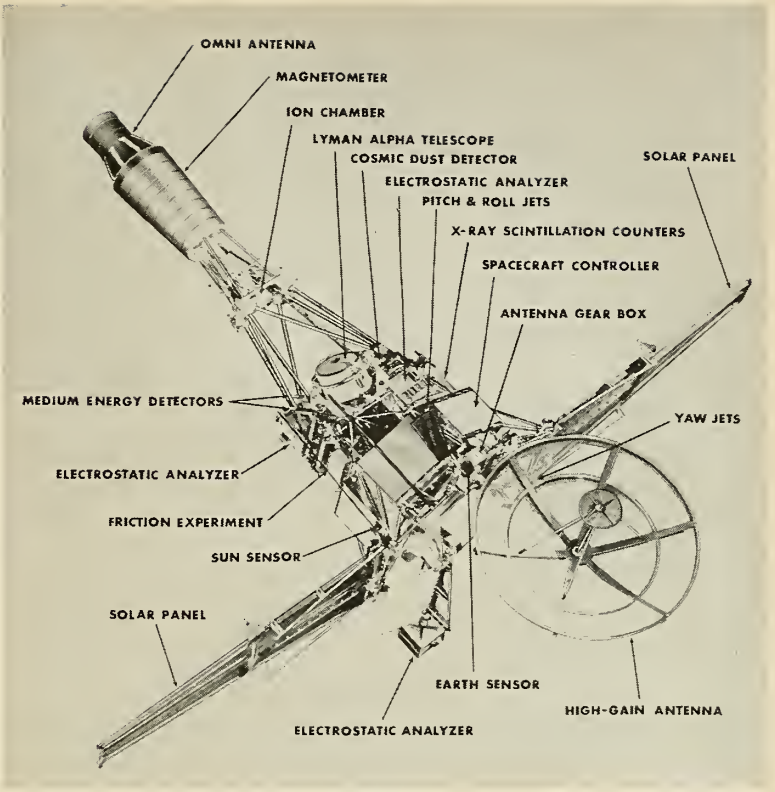
—Fifth Command—This takes place at 90 minutes and forces *Ranger*—now locked on the sun—to start looking for the earth. The spacecraft then starts to roll on its long axis pointed toward the sun, with its directional antenna extended at a precalculated attitude. During the roll, the earth sensors will see the earth and inform the gas jets. The jets will fire to keep the earth in view of the sensors—and thus lock onto the earth.

—Sixth Command—This occurs at 118 minutes and changes the scale factor of telemetry measurement of the wobbling *Ranger* went through when separated from *Agena B*. The wobbling —now under the control of the attitude control system—has considerably lessened and the scale factor must be reduced.

—Seventh Command—At 200 minutes, it makes an instrument in one of the experiments more sensitive, to provide a finer measurement of the radiation levels encountered.

—Eighth Command—This occurs at 250 minutes and transfers data being sent from the three-watt transmitter from the omnidirectional antenna to the directional antenna, thereby greatly increasing the range from which the information can be sent.

—Ninth Command — This takes place at 366 minutes, 40 seconds. It consists of a reduction in the rate at which the quarter-watt transmitter has been sending data over the omnidirectional antenna. The low-power transmitter now is near its limits because of distance, so that the amount of information it sends is reduced and its ability to communicate over longer distance is improved.



DETAILED DRAWING of Ranger spacecraft.

—Tenth Command—This occurs at 370 minutes and turns on an engineering experiment to try to determine some of the friction forces involved in the operation of machinery in the hard vacuum of space.

• **Experiments**—The eight experiments included in *Ranger I* are some of the most important attempted by U.S. space scientists. They include:

—Solar Corpuscular Radiation Experiment—To determine the flow and movement of interplanetary plasma (clouds of charged particles) by observing the density and direction of motion of drifting plasma clouds and also by measuring the energies of the particles which make up these clouds.

—Medium-Energy Range Particle Detectors — Six medium-energy range particle detectors will observe charged particles in an energy range which overlaps the lower energy range of the solar corpuscular radiation experiments and which extends upward toward the high energies of the fast-moving cosmic rays.

—Cosmic-Ray Ionization Rate Measurement—Primary cosmic radiation and other ionizing radiation in the space beyond the earth's atmosphere will be measured by a quartz fiber, integrating tube ionization chamber.

—Triple-Coincidence Cosmic Ray Experiment—High-energy radiation in interplanetary space will be measured by an instrument composed of two triple-coincidence telescopes, each of which has seven proportional counter tubes.

—Magnetic Field Experiment—*Ranger* carries a rubidium vapor magnetometer to measure the strength and direction of the magnetic field in interplanetary space.

—Solar X-Ray Detection—A pair of scintillation counters are mounted on *Ranger* to detect bursts of low-energy X-rays originating at the sun. The equipment is designed to detect extremely short-term variations in the X-rays.

—Neutral Hydrogen Geocorona—This experiment employs a telescope and a detector sensitive to the Lyman-alpha region of the spectrum (the color of the neutral atomic hydrogen gas) which will scan the region containing the earth.

—Cosmic Dust Detectors—Impact rate, energy, momentum and direction of flight of dust particles in interplanetary space will be measured by a miniature cosmic dust detector. ⌗

Shaky success...

MR-4 Winds Up Suborbital Series

by Hal Taylor

CAPE CANAVERAL—Flight of *Mercury Redstone 4*—perhaps the closest success ever came to failure—apparently was the last U. S. manned sub-orbital shot down the Atlantic Missile Range.

Only totally unexpected telemetry evidence of capsule malfunction could require a third such shot and, judging from preliminary data, this seems highly unlikely.

NASA officials are expected to decide this week to drop the *Redstone* series and concentrate on *Mercury Atlas* orbital shots. The next in this series, an unmanned *MA-4*, has slipped from mid-July to early September.

NASA has discovered that the loss of the $2-million "Liberty Bell 7" capsule aboard *MR-4* July 21 could have been avoided—except for a faulty warning light. Marine Helicopter Pilot Lt. James L. Lewis, who was retrieving the waterfilled capsule, cast it loose when the warning light indicated the helicopter's engines were overheating.

The capsule sank in 18,000 fathoms of water.

Subsequent investigation showed nothing wrong with the engines, but with the light.

Astronaut Virgil L. "Gus" Grissom himself narrowly escaped drowning at the end of the 15-min., 118-mi.-high and 303-mi.-long flight when an escape hatch blew out prematurely, flooding the capsule. Grissom had to swim through it to safety. A neck dam kept his space suit from filling with water and also trapped air in the suit, providing buoyancy at first. However, the suit did start to fill from a port he had left open; by the time he was picked up by another helicopter, Grissom was fighting hard to stay afloat.

Except for the unexpected blow-out of the escape hatch, Grissom's flight was almost a carbon copy of the 116.5-mi.-high and 302-mi.-long flight of Cmdr. Alan Shepard May 5, and was fairly close to the programed 116-mi. apogee and 287-mi. distance.

• **Operational problem** — Although there was speculation that RF energy from the helicopter might have actuated the explosive charge, NASA officials said telemetry showed nothing wrong technically with the escape hatch mechanism. They put it down as an operational problem not requiring any design changes.

The space agency presently plans to set up a procedure under which safety pins—which prevent its premature release—will be kept in the hatch mechanism until the astronaut is ready to make his exit.

It also plans further egress training for the astronaut and the Marine helicopter rescue team. Many rehearsals will be run through in an attempt to smooth out and speed up the lowering of two lines to the capsule simultaneously with lowering the harness to pick up the astronaut.

A review also has given the capsule's control system a clean bill of health. Grissom reported shortly after the flight that he did not get the movement expected while using the attitude control system. Telemetry records indicate that the system worked perfectly. Grissom's statement, according to NASA officials, probably stems from the fact all of his earlier experience in using the system was at sea level. The reaction of the controls is a little slower in powered flight.

Grissom also said that his HF (high frequency) radio did not work during his flight. The space agency says that it never expected the HF radio to work particularly well on suborbital flight. It is intended as a backup for the ultra-high-frequency radio on orbital flights, when it will be used for skip transmission ranges.

NASA officials also expressed complete satisfaction with the performance of the *Redstone* booster. They pointed out that the planned velocity was 4480 miles per hour, and the space agency got 4510 miles. The slight variation resulted in 1½-mile higher altitude than planned. ⁂



ASTRONAUT GRISSOM vainly tries to assist Marine helicopter in recovery of Liberty Bell 7 capsule. Minutes later he nearly sank himself.

For ComSat System . . .

Carriers Plan Non-profit Ownership

INTERNATIONAL carriers are expected to advance a new plan wherein they would create a non-profit corporation to own and operate a U. S. commercial communications satellite system.

The plan presumably would rule out any profit-sharing in the venture by missile/space industry firms, other than those already in the communications business.

American Telephone & Telegraph and Radio Corp. of America are reported to have authored the plan in answer to a scheme put forth by General Electric to create a profit-making "carrier's carrier" which would own and operate a ComSat system.

Existence of the new plan became known as the Federal Communications Commission last week ordered the eight U. S. international carriers to set up an *ad hoc* committee to recommend proposals for ownership and operation of the system. The FCC acted following a White House policy decision favoring private ownership of a commercial system (see box).

GE and Lockheed Aircraft Corp., which also has sought ownership participation, were excluded from the *ad hoc* committee. FCC officials denied that this meant GE and Lockheed were now out of the running, contending that their proposals would be given equal consideration with those of the carriers.

All of the commission's orders and decisions in the protracted struggle over ownership of the system have stressed the role of the communication carriers and excluded missile/space firms. Hence, it seems clear that if the carriers' new plan fills Administration criteria, it will get the go-ahead.

The plan which AT&T and RCA will present to the committee envisions a non-profit corporation in which the carriers would have equal representation with, perhaps, three directors representing the general public.

Profits for the carriers would come from the toll rates received for traffic originating in their own ground stations.

While chances of the missile/space industry proposals appear slim, there is still the possibility that Congress will insist upon wider ownership participation. There is also the remote chance that the communications carriers will be unable to come to an agreement. GE could also apply to FCC for an international communication carrier license.

The FCC told the *ad hoc* committee to prepare a plan for presentation to the Commission not later than Oct. 13.

Besides AT&T and RCA, the committee will include American Cable and Radio Corp., Press Wireless Inc., Hawaiian Telephone Co., Radio Corporation of Puerto Rico, South Puerto Rico Sugar Co., Tropical Radio Telegraph Co., U. S. Liberia Radio Corp., and Western Union Telegraph Co.

The group is to use the criteria laid down in the President's statement. ⌗

Text of President Kennedy's policy statement on a commercial communication satellite system:

A. POLICY OF OWNERSHIP AND OPERATION

Private ownership and operation of the U.S. portion of the system is favored, provided that such ownership and operation meet the following policy requirements:

1. New and expanded international communications services be made available at the earliest practicable date;

2. Make the system global in coverage so as to provide efficient communication service throughout the whole world as soon as technically feasible, including service where indivual portions of the coverage are not profitable;

3. Provide opportunities for foreign participation through ownership or otherwise, in the communications satellite system;

4. Non-discriminatory use of and equitable access to the system by present and future authorized communications carriers;

5. Effective competition, such as competitive bidding, in the acquisition of equipment used in the system;

6. Structure of ownership or control which will assume maximum possible competition;

7. Full compliance with antitrust legislation and with the regulatory controls of the Government;

8. Development of an economical system, the benefits of which will be reflected in overseas communication rates.

B. POLICY OF GOVERNMENT RESPONSIBILITY

In addition to its regulatory responsibilities, the U.S. Government will:

1. Conduct and encourage research and development to advance the state of the art and to give maximum assurance of rapid and continuous scientific and technological progress;

2. Conduct or maintain supervision of international agreements and negotiations;

3. Control all launching of U.S. spacecraft;

4. Make use of the communications satellite systems when required to meet unique Government needs which cannot, in the national interest, be met by the commercial system;

5. Assure the effective use of the radio-frequency spectrum;

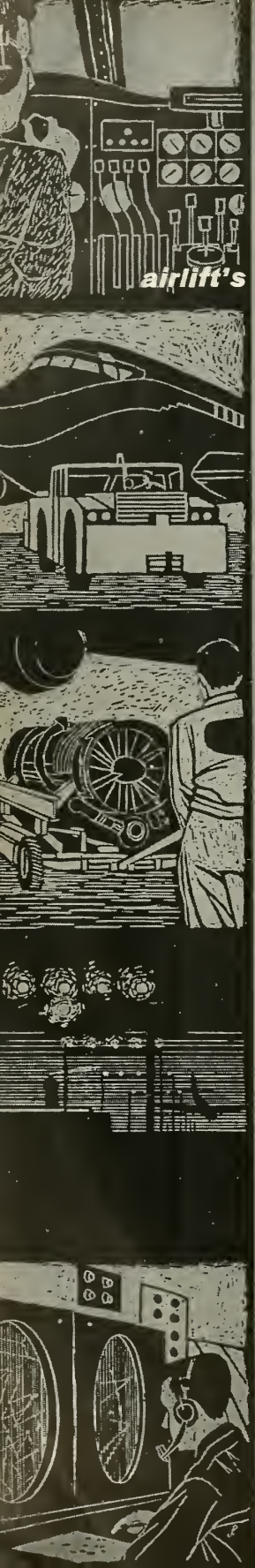
6. Assure the ability to discontinue the electronic functioning of satellites when required in the interest of communication efficiency and effectiveness;

7. Provide technical assistance to newly developing countries in order to help attain an effective global system as soon as practicable;

8. Examine with other countries the most constructive role for the United Nations, including the I.T.U. (International Telecommunication Union), in international space communications.

C. COORDINATION

I have asked the full cooperation of all agencies of the Government in the vigorous implementation of the policies stated herein. The National Aeronautics and Space Council will provide continuing policy coordination and will also have responsibility for recommending to me any actions needed to achieve full and prompt compliance with the policy. With the guidelines provided here, I am anxious that development of this new technology to bring the farthest corner of the globe within reach by voice and visual communication, fairly and equitably available for use, proceed with all possible promptness.



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Technical Countdown

MATERIALS

Residual Machining Stresses a Problem

Industry is still hunting complete, accurate and practical data on residual machining stresses remaining in critical components after fabrication. In one instance, a case of large precision gears—finished, inspected and approved, were waiting shipment. One morning several of the gears were found split and cracked, presumably from undetectable internal stress induced during machining.

New Hydrospin at Avco-Lycoming

A vertical Cincinnati Hydrospin machine has been installed at Avco-Lycoming. The device is capable of shear-forming parts up to 72 in. across and over 144 in. long. It can easily be equipped with flame devices to form magnesium alloys, titanium, molybdenum and other metals requiring heat. The new machine increases Lycoming's capabilities in the motor case market.

Rhenium-Tungsten Alloy Strip in Production

Chase Brass and Copper Co. is producing rhenium-tungsten alloy strip in commercial quantities. The alloy is used primarily in grids, heaters, cathode supports, thermocouples, electrical contacts and welding filler rods. Powder metallurgy methods are used.

Huge Centrifuge A-building at Pt. Mugu

Rucker Co. will design, build and install a 32-ft.-diameter disc centrifuge at the Navy's Missile Center, Pt. Mugu, Calif. The system will test concentrated packages up to 5000 lbs. in weight. Rated at 50,000 g-lbs. acting 24 in. above the top of the disc, the system will simulate all g forces a missile would be subjected to in flight. Maximum acceleration will be 100 g.

Moly Arc-Castings Ductile

Oregon Metallurgical Corp has produced molybdenum sufficiently pure to be ductile before any mechanical working. Coupons cut from the as-cast ingot showed a 37,000 psi yield strength, 46,000 psi ultimate, 3.5% elongation in 4D and a 3.2% reduction in area at room temperature. The work is sponsored by the Navy's Bureau of Weapons.

PROPULSION

AF Headache—Storables

Despite commitment to current design, the Air Force is still looking for great improvements in the elastomeric seals used in the storage-fueled *Titan II*. Project spokesmen say that nitrogen tetroxide is especially hard to handle during long storage periods.

Case Wound Grains Fired

Aerojet has fired a number of small solid rockets fabricated by winding the glass case directly on the live grain. Another wrinkle in case technology is the firm's technique of plating control and other electrical circuitry directly onto the motor case. The method is believed to be highly reliable and unaffected by heat, vibration and other extremes.

Upper Stage Solid Propellant

Test-firings at extremely low (less than 200 psi) chamber pressures with high combustion efficiency have been achieved by Grand Central Rocket with its Polycarbutene-R propellant. The possibility of using light motor cases aids in reaching high-propellant mass fractions. The GCR propellant fired at low pressure contained substantial amounts of powdered aluminum, once considered a major obstacle in such firings.

Calibrated Flowmeter Licensed

Rocketdyne-developed Volumetric Flowmeter Calibrator —a method of calibrating flowmeter systems to an accuracy said to be greater than by any other method—has been licensed for production and sale to Norlac Engineering and Mfg. Co., Culver City, Calif. Currently in use at Rocketdyne-Neosho, the device consists of a pressurized supply tank, test and flow control station, volumetric standpipe and return unit and a control and recording unit. Calibration is effective over wide ranges of pressure and flow rates.

ASW & SEABORNE SYSTEMS

Drone Extends ASW Striking Power

A remotely-controlled drone—nicknamed DASH (Drone Antisubmarine Helicopter)—has extended the Navy's ability to hit hostile submarines to the limits of its sonar detection capability. Flown from the deck of a destroyer, the Model DSN-1 coaxial-rotor helicopter is armed with homing torpedoes and allows the Navy to attack subs before the enemy craft become aware of the attack. The new drone was developed and produced by Gyrodyne Company of America, Inc.

ELECTRONICS

Feedback Communications Under Study

A study program to improve understanding of the operation of feedback communications systems is being undertaken by Sylvania for the Air Force. Communications systems of this type continuously monitor the received signal strength, and, by feeding this information back to the transmitter, can vary its transmitted signal to maintain high communications performance levels. Systems of this type are expected to yield substantially improved communications.

ASTRONAUTICS

Digging a Hole on the Moon

Tests conducted at NASA's Lewis Research Center with high-pressure jets impinging into beds of sand in a vacuum chamber indicate that the retro-rockets of a lunar spacecraft will dig a sizable hole upon landing. After up-scaling the test results, NASA scientists found that, with a jet nozzle located 100 feet above the lunar surface, a hole some 30 feet deep and 100 feet in diameter may be produced. It was also found that the sand particles are thrown up and out, leaving a dust-free central cone for the landing craft.

Ballistic Actuator Would Open Silo o

by Frank G. McGuire

MESA, ARIZ.—Even if buried in a nuclear attack the Air Force's *Minuteman* will still be able to retaliate—thanks to a solid-powered ballistic acuator system for removing the silo lids.

An actuator produced for The Boeing Co. by Talley Industries, Inc., exerts some 350,000 lbs. of force to remove the lid and any debris that might be covering it after an enemy assault. Boeing expects that the maximum load will total about 160,000 lbs. The actuator will move that weight eight feet in less than six seconds.

Operating by means of a pulley system, a cable will transmit the eight-foot piston movement to the lid, unlocking it and giving initial movement to send it away from the silo, plowing away debris in its path. The concrete and steel lid will then roll on steel rails across the apron of the silo.

Talley has already completed preliminary development of the actuator under a $56,000 contract, and has received a $79,000 follow-on contract for further development and qualification.

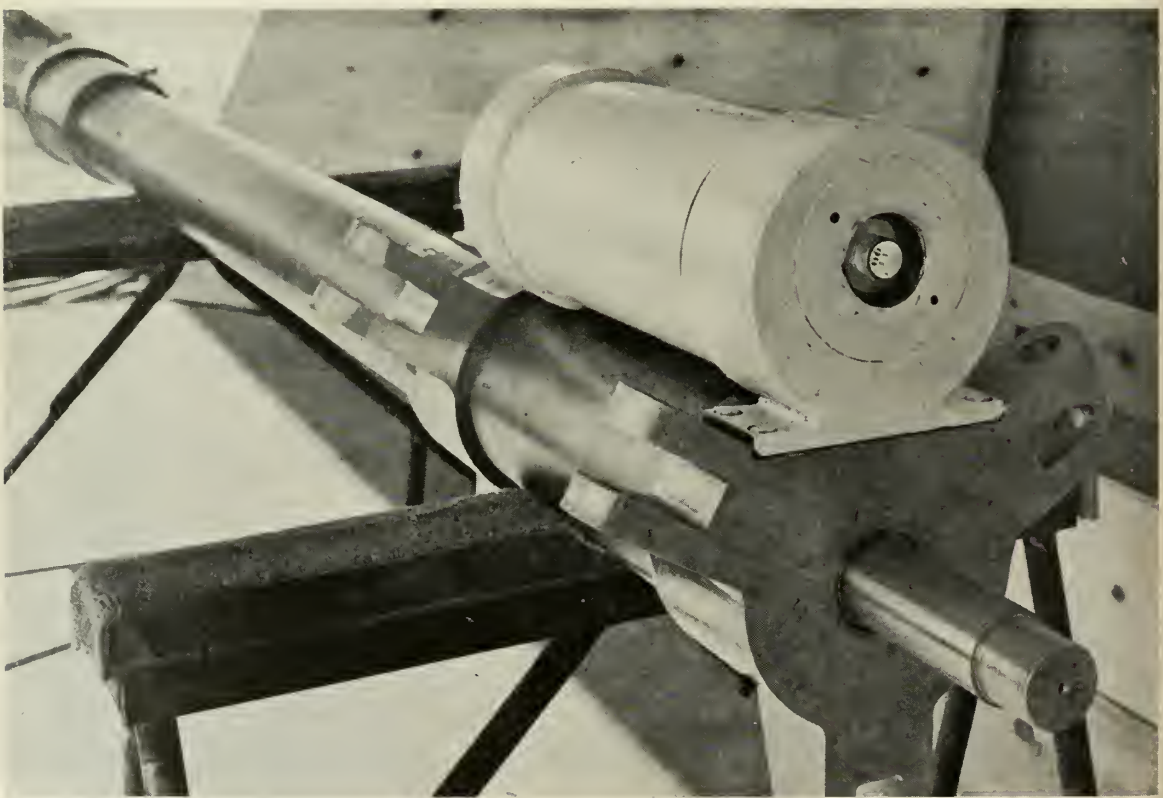
Talley is the sole source on the lid-removal system. A similar contract has been awarded the firm by the Army for development of a solid-propellant lid-removal system for the *Titan II*. This contract is for $497,000.

G. E. Hirt, vice president of Talley, said the *Minuteman* actuator represents the first time industry has broken away from the concept of relying on electric motors instead of ballistic actuators for such a vital application.

"This type of actuator has often been used as a backup system," Hirt said, "but never as the sole energy source where so much is at stake."

The noiseless actuator utilizes over three pounds of a very stable ammonium nitrate propellant. It can be stored over a year, then maintaining full operational capability during at least three years in position. One unit will be used per silo—and Boeing's confidence in the Talley device is such that no backup system is planned for the application.

Operating pressure will vary from 400 to 15,000 psi under varying load conditions, but the actuator cylinder has been built to withstand a peak pressure of at least 20,000 psi. Ignition of the main propellant charge is assured through the temperature range −45°F to +160°F, by 13 TEX 506 charges



ACTUATOR CARTRIDGE atop cylinder. The cartridge is sealed at one end by a styrofoam closure which ruptures at approximately 25 psi. The seal keeps hot igniter particles in the cartridge long enough to insure ignition before gas is released.

Minuteman after Nuclear Attack

1.1-in. long, uninhibited on both ends.

The bore of the cylinder, as well as the piston, has been hard chrome-plated to protect the surfaces against any corrosive action of the propellant gases during repeated firings for silo lid removal. Backup rings have been included in the piston and bearing insert seals to prevent failure.

The end cap assembly has been machined to provide for a scraper that will prevent foreign material deposited on the piston rod from interfering with the operation of the actuator over a period involving a number of firings.

Design of the cartridge assembly was carried out as a result of a computer study program conducted at Princeton University last year.

The propellant cartridge is sealed at one end by a styrofoam closure which ruptures at about 25 psi. The seal performs two functions in that it keeps the hot igniter particles in the cartridge long enough to insure propellant ignition before releasing gases into the main cylinder, and when covered with an epoxy resin acts as environmental seal.

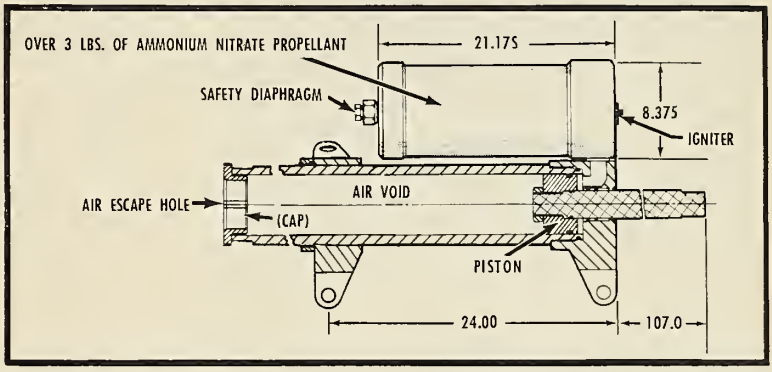
Peak resisting load in the system occurs about 18 inches from the top end of the cylinder.

Talley says it is apparent that the propellant grain can, at −40°F, produce sufficient gas to move the piston through its 96-in. stroke in barely three seconds without exceeding 0.25 g on the piston.

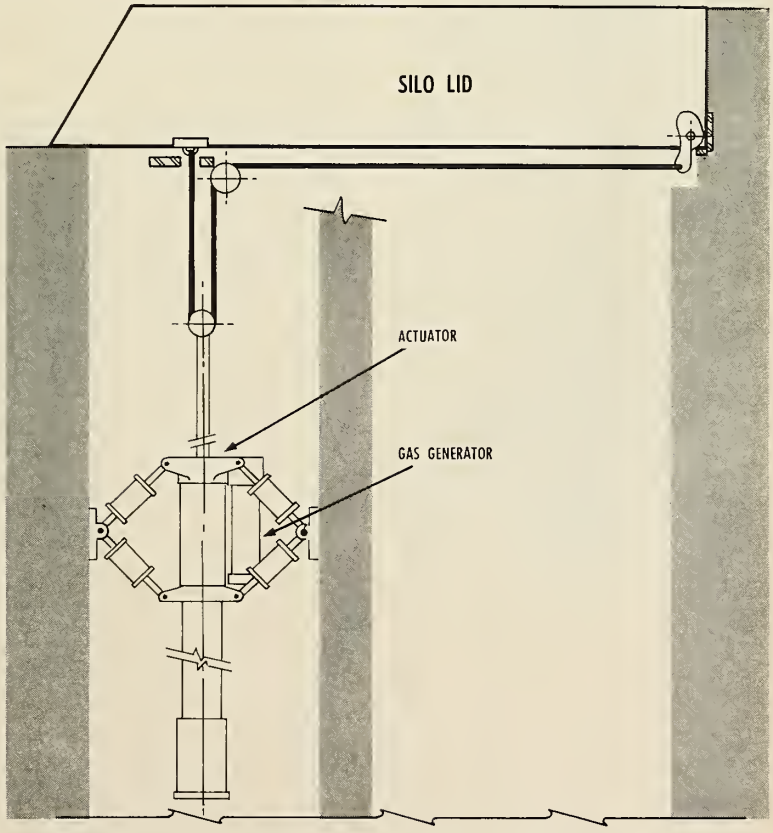
• **Simulator design**—Due to the undesirability of completely duplicating a *Minuteman* silo at the Talley facility, a simulator was developed, described by Hirt as "the biggest water pistol in Arizona."

The device consists of a cylinder filled with water and having a hole at one end. A variable diameter probe is positioned to move through the hole, giving variable resistance to the piston, which exerts force on the water from the opposite end of the cylinder. By carefully machining the probe, Talley was able to control the water expulsion and thereby duplicate the resistance expected at various phases of the silo lid removal.

Several different probes were used, to simulate varying load conditions anticipated during operation. ⌘



CUTAWAY OF ACTUATOR. It can be stored for longer than one year and then maintain full operational capability for at least three years in position.

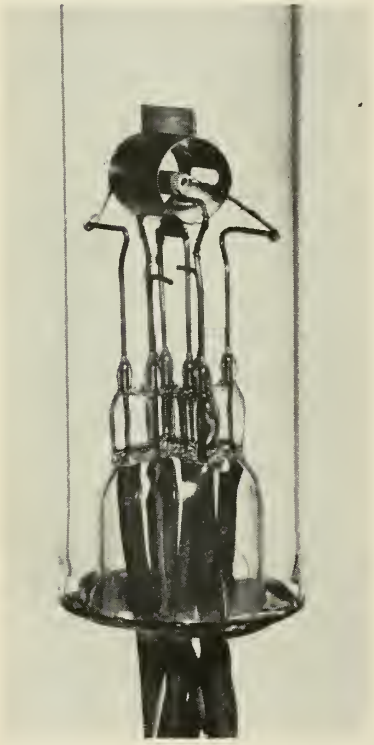


IN MINUTEMAN SILO, eight-foot piston movement created by Talley actuator would be transmitted to lid by means of a pulley system. Total force: 350,000 lbs.

Door Open to 'Low-Temp' Thermionics

FICO-built converter spells longer life for cells using readily available materials; a step toward noiseless subs

by William Beller



LOW-TEMPERATURE, wide-gap thermionic test cell. This is a close-up of a cylindrical-geometry type.

LONG ISLAND CITY, N.Y.—A thermionic converter which can operate at much lower temperatures than had been thought possible for reasonable performance is emerging from the research stage at Ford Instrument Co.

The achievement of a relatively low-temperature converter is highly significant. It means that readily available materials can now be used in the cells, because high-temperature problems have been reduced. It also means that the life of the materials can be greatly prolonged, thus enhancing system reliability.

In a broader view, the cells may be bringing the Navy a little nearer to realizing its dream of a noiseless submarine powerplant. It may also mean that solar thermionic power generators will become easier to design. And "low-temperature" thermionics undoubtedly can open up many applications not practical with present cells.

Test cells have already shown conversion efficiencies up to 15% and densities of 5 watts per square centimeter, at the surprisingly low temperature of around 1200°C. This operating temperature is far lower than that of other converters, whose emitters usually work at about 1800°C.

These research test cells have been operating on a laboratory basis at Ford Instrument for nearly a year. Until now they were given no publicity because the scientists wanted to be sure that the test results would repeat themselves.

Theodore Jarvis, who heads up Ford Instrument's thermionics work, says that within six months the company will be going from glass models to metal-ceramic ones; within a year, he expects, the company will be having production units.

• **Wide gap used**—The secret behind the Ford Instrument work is that an ultra-low-voltage arc is struck and maintained between the cell's emitter and collector; other cells don't use an arc. An additional, striking development is that the gap between the emitter and collector is 0.1 in.—one or two orders of magnitude bigger than the gap used in other cells.

Jarvis says that a little over a year ago he was experimenting with a thermionic triode. He noticed that once an arc was established, reducing the grid temperature had no effect on the current. He concluded that the grid was only a triggering device to get the arc started. Once it was established, Jarvis found he could get good thermionic efficiencies with relatively low plate temperatures.

The operation of the thermionic tube is often compared to that of the vacuum tube diode. In each, electrons are boiled off the emitter or cathode, migrate across the interelectrode gap, and condense on the collector or anode. In the thermionic tube, this current of electrons passes through a load, does work, and returns to the emitter for another cycle.

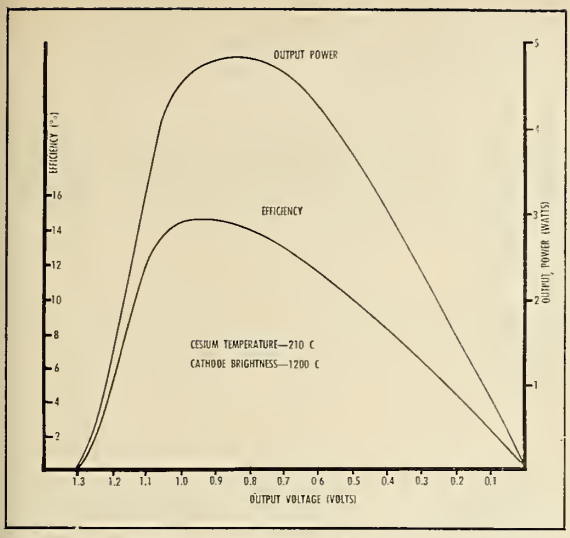
The gas-filled or cesium cell is popular today because it lessens the space-charge in the tube, makes suitable contributions to the work functions of the emitter and collector, and allows a larger interelectrode gap than the vacuum cell. Ford Instrument's converter is the cesium-gas type.

• **A theory needed**—At present, no one appears to have a reasonably full understanding of the theory behind the ultra-low-voltage arc converter. However, the process does involve direct electron-produced ionization within the volume of the arc discharge, and does not involve surface effects caused by Langmuir-type ionization.

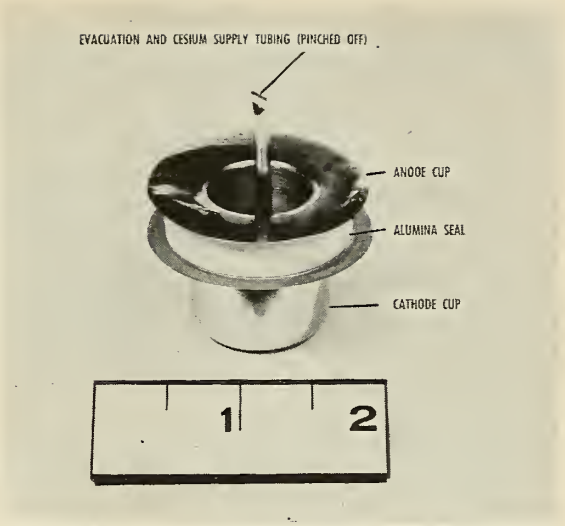
The discharge is described as distinguished by a rapidly rising potential within the discharge itself up to a potential maximum. This maximum may be a localized "ball-of-fire discharge" that in some instances fills the entire interelectrode spacing—the Langmuir discharge.

The ion-producing electron reactions take place inside this reaction zone. The conduction electrons, as well as those which caused excitations and ionization of the neutral atoms, then drop to the collector and complete the circuit.

All of the foregoing characteristics of the ultra-low-voltage arc have been observed during the experimental work at Ford Instrument. As the interelectrode gap is reduced below about 0.07 in., or if the current density drops significantly the arc is extinguished. This phenomenon is said to be consistent with the requirements that a certain number of electron-scattering mean-free patterns exist between the emitter and collector for the arc to be sustaining.



OUTPUT POWER and conversion efficiency characteristics of cylindrical-geometry type cell.



MOCK-UP OF FORD INSTRUMENT'S metal-ceramic "low-temperature" thermionic cell.

Here are some uses foreseen for the development—if it lives up to its promise:

—In the antisubmarine warfare field, a nuclear reactor would furnish heat to a thermionic-cell array, which in turn would generate—noiselessly and reliably—a submarine's electrical power. Since the cells would not have to be integral with the reactor cores but rather could get heat from the reactor coolant, the reactor itself could be almost completely isolated—thus making shielding a relatively easy problem.

—Solar power will be fairly easily stored and used. For instance, heat-storage for cells operating in the 1800°C range is extremely difficult. Therefore, earth-orbiting satellites using thermionic cells would have to store electrical energy for darkside operations. On the other hand, if the emitter can be operated off a 1200°C source, an extremely simple and lightweight beryllium heat-storage unit could energize the cell during its dark periods.

—Lower temperature operation also means that the solar mirrors serving thermionic arrays would not have to be as accurately oriented as they would for higher temperature operation.

—Chemical combustion can also be used as an energy source for the Ford Instrument cells. Such a use was recently announced by Atomics International; the company has operated a conventional "cesium vapor diode" with the heat input from combustion of propane gas.

Part of Ford Instrument's work on thermionics is done under a Wright Field contract. It calls for developing and operating a 75-watt electrically heated thermionic cell which will demonstrate the performance of low-temperature plasma conversion.

In addition, under an Office of Naval Research contract, Ford Instrument is studying the fundamental nature and characteristics of pure-cesium and cesium-oxygen plasma arcs.

• **Thermionics today**—Through ONR's Power Branch and LCDR John J. Connelly, who manages many of its thermionics programs, the Navy has become one of the chief backers of fundamental thermionic research. Also, the Air Force, Advanced Research Projects Agency, NASA and the Atomic Energy Commission are firmly in the field. Here are some more interesting programs:

ONR has a joint program with the General Motors Research Laboratory to develop a noble-gas plasma diode. The converter is described as consisting of a uranium-bearing cathode, low work function anode, and a noble gas in which a plasma is formed by fission fragment ionization.

In another ONR program, Atomics International is looking into the feasibility of using a thermionic diode for direct conversion of heat to electrical power in large nuclear powerplants.

General Atomic is studying the thermionic emission characteristics of UC, ZrC and combinations of the two compounds for potential emitter materials in a cesium plasma diode.

Republic Aviation Corp. is looking into the effects of magnetic fields on the electron transfer between emitter and collector. One intriguing aspect of this work calls for applying magnetic modulation in an attempt to generate an alternating current.

Allied Research Associates, Inc. is studying the atomic and solid-state structural factors of thermionic converter materials. This should lead to knowledge of the classes of materials, and even the materials themselves, which are best suited for thermionics.

Armour Research Foundation is studying the problems apt to be brought up in choosing seals and insulators for thermionics. And North Carolina State College is reviewing all ONR contracts on thermionic energy conversion. ❖

Characteristics of 'Low-Temperature' Thermionic Cell

Geometry	—cylindricol
Cothode moteriol	—impregnated tungsten, Philips Type 8
Cothode dimensions	—0.156 in. D x 0.375 in. L
Cathode surface oreo	—0.184 in.^{2} = 1.18cm^2
Cathode emission oreo	—approximately 1.0 cm^2
Anode moteriol	—sheet molybdenum, 0.020 in. thick.
Anode configurotion	—cylindrical with four longitudinal fins
Anode dimensions	—0.35 in. D x 1.50 in. L
Anode fin dimensions	—0.40 in. W x 40 in. T x 1.50 in. L
Totol externol onode oreo	—5.0 in.^{2}
Cothode-to-anode spocing	—0.10 in.

New Army Timers Combine Small Size

Honeywell-developed outgrowth of Asroc unit has shown accuracies to 0.1%; hundreds of military and commercial uses seen

by Charles D. LaFond

NEW, RUGGED, 50-hour timers now being developed for the Army could push all conventional timing, fuzing, and arming devices into obsolescence.

One of these—a tiny solid-state magnetic-core timer—is so promising its developers will soon place it in quantity production for commercial and industrial use.

A second-generation outgrowth of the *Asroc* magnetic timing unit, the Minneapolis-Honeywell-developed subsystem has demonstrated accuracies to 0.1% over a wide temperature range. One-cubic-inch timers are now being environmentally tested by the Army's Diamond Ordnance Fuze Laboratories (DOFL) in an extension of its Copperhead fuze-improvement program.

Not only is the new unit an advancement in the art of timer-circuitry design, but Honeywell believes that the fabrication techniques employed also represent significant technological achievement.

Although DOFL funded it, the sponsor of this program to develop advanced 50-hour timers is the Army's Piccatinny Arsenal at Dover, N. J. Three organizations are involved in the three-pronged development approach: Minneapolis-Honeywell, DOFL, and International Telephone and Telegraph Corp. First end-use is still classified, according to Piccatinny Arsenal.

Honeywell's development task required use of transistorized circuitry and a low-frequency magnetic-core oscillator; DOFL, nearly all-magnetic circuitry; ITT, a high-frequency crystal oscillator and transistorized circuitry.

All of the new timers are considered more highly advanced than those resulting from DOFL's Copperhead program (M/R, July 17, p. 119). State-of-the-art switching is employed to permit interrogation prior to final timing.

Any of the timers can be cascaded for any desired total time. The limiting factor is the available power source.

Each timer was built in nine months, according to DOFL, and environmental testing of prototypes will require a total of several months.

In the magnetic timer business since 1955, Honeywell developed its first units solely with in-house funds. It is now setting up automated production lines. Devices so far have employed manually welded circuitry.

Even with current fabrication techniques, the company says, it can effect savings up to 66% over conventional timers.

Key to the success of the M-H timer is the magnetic core's ability to integrate a voltage with respect to time. This provides a means for generating accurate time intervals. Used with a few counter stages, these timers provide very long, extremely accurate time delays.

Use of the magnetic timing technique with solid-state circuitry has achieved characteristic accuracies of better than 0.5% over a temperature range of −65° to 165°F and a ±10% voltage variation. More advanced versions, developers say, are accurate to ±0.1% and are approaching ±0.05%. Some devices have been tested up to 250°F with the same accuracy.

Repeatibility at constant temperature is reported to be better than 1 part in 10^5.

• **Typical interval timer**—The complete timer circuit is comprised of a low-frequency magnetic oscillator and a three-stage decade divider.

The oscillator generates a square-wave output pulse nearly immune to the frequency drift normally caused by ambient temperature changes and/or supply voltage fluctuations.

Oscillator pulse frequency is used as a base; the decade counter totals the number of pulses produced over a period of time. An output signal is produced upon the accumulation of a predetermined pulse count. The latter is determined by the desired time interval.

The output signal can be either a





FABRICATION of welded 5-stage ring counter (left) with high-voltage (200 vdc) readout. Component density, says Minneapolis-Honeywell, is 225 parts/cu. in. Counter is used in new 50-hr. magnetic-core timer developed for Army (Right) Finished timer—size: under 1 cubic inch.

ligh Accuracy



COMPLETE TIMER package provides time-base magnetic-core oscillator, welded circuitry for countdown, "time-remaining" readout, final output, and battery power supply. Unit weighs under 1 lb., occupies 35 cu. in.

momentary high-current pulse derived from the timer power supply or a solid-state switch closure. The latter could be used to control some external function.

Variations in time-interval length are practically unlimited, since oscillator frequency and pulse count used to produce the output signal can be selected at the time of manufacture.

Also, Honeywell indicates that where sequentially occuring events demand accurate programing, interstage output leads from the decade counter can be used to provide intermediate timing pulses prior to final output pulse.

• **Design characteristics**—Honeywell engineers feel that elimination of crystals or mechanically resonant devices normally used to generate the time base produces a device capable of withstanding unusually severe shock and vibration environments.

They indicated that it is conceivable that such a device could experience an impact so intense as to alter the characteristics of the saturable magnetic core.

However, magnetic timers have been subjected to shock levels as high as 4000g with negligible effect on core characteristics.

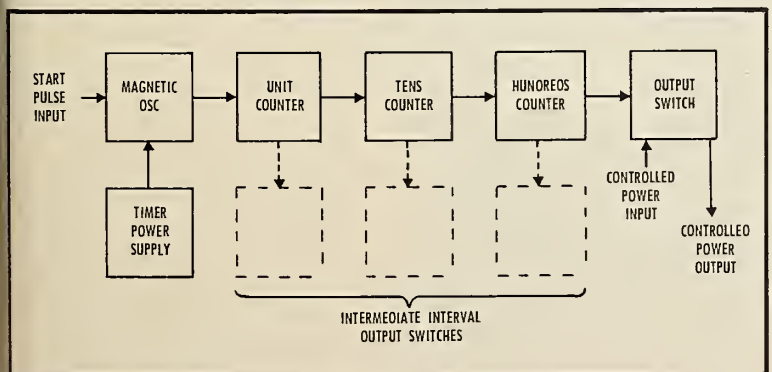
The timers reportedly meet all standard MIL spec vibration test requirements with ease; centrifugal forces at spin velocities encountered in gun-fired projectiles cause only negligible effect on timer accuracy.

• **Power needs low**—The magnetic oscillator operates at a very low pulse rate: thus, in a 5-sec./cycle interval timer, countdown stages are not required. Only a few would be required for longer interval timers. Because of this, power requirements are considerably lower than those required by higher-frequency crystal oscillators using many stages for the same time-out interval.

Honeywell states that a typical 5 sec./cycle magnetic oscillator uses 8 milliamps at 6 volts. Each additional decade counter stage would increase this by 1.5 milliamps at 6 volts.

Such timers can be packaged within a volume of 1 cu. in. Each added decade counter stage requires another cubic inch of space. (A 100-sec. interval timer can, says Honeywell, be encapsulated in a total volume under 3.4 cu. in., or roughly 1.5 in. on a side.)

• **Reliability high**—With its package density, solid-state circuitry and small number of components, the timer is believed to provide inherent high reliability. This is further increased by the use of components in an on-off low-power dissipation mode.



MAGNETIC timer block diagram.

DOFL is now conducting paper reliability studies, but has yet to report any results.

Honeywell is now performing life studies of its units. One has been operated so far for over 2 weeks, with total frequency shift stabilized at an accuracy of 0.04%.

Results are not yet available from DOFL's long-term environmental stability tests. These should be completed by mid-August.

• **Packaging**—Component density in the Honeywell timer is equal to 225 parts/cu. in., the company says.

New techniques in vapor deposition have greatly aided the fabrication of these devices. In one six-stage ring counter, company engineers have deposited 38 resistors on a single substrate. Prior to this, it is believed the largest possible number was eight.

Although somewhat less accurate than crystal oscillators, the Honeywell units are believed to be more rugged. They are considered equal in other respects to timing-fork types, but capable of withstanding higher vibrational effects.

• **Applications**—In addition to their potential as satellite or missile programers, and as fuzes for torpedoes, mines and artillery, the magnetic timers could have hundreds of other applications, in Honeywell's opinion. It is for this reason that the company is going ahead with set-up of new production facilities.

For, beyond the standard uses in timing and programing, the company foresees an equally broad use for its device in integration—some parameter with time.

All that is required is a suitable variable d-c voltage to apply to the magnetic core. For example, the d-c output from a temperature sensor could be used to vary the output as a function of temperature. The timer thus would function as a time-heat integrator.

Similar functions are possible with output from strain gages, accelerometers, or other sensors. ⁂

Biggest Dynapak in Operation at Brake Shoe

Company bids to advance in forging work; costly metals formed in intricate shapes

AMERICAN Brake Shoe Co. is moving to strengthen its position in the aerospace forging market through high-energy-rate forming processes.

Metallurgists at the firm's research center in Mahway, N.J., are conducting a series of forming experiments on the world's largest Dynapak vertical metal-working machine.

The machine is capable of forging, extruding, compacting and blanking. Brake Shoe has used it successfully to shape tungsten, molybdenum, titanium, columbium and zirconium.

The firm is primarily interested in forging and compacting applications, but a pit has been constructed beneath the machine to permit limited extrusion experiments as well.

The high-energy-forming Dynapak was developed by Convair, division of General Dynamics (M/R, April 25, p. 37). Its operation is based on the principle of pneumatics. One chamber holds nitrogen gas at high pressures. When the machine is cocked, low-pressure gas in a second chamber holds the working piston against an orfice plate.

A seal in the piston face isolates from the high-pressure gas all of the pistons surface except the small area surrounded by the seal. With the high-pressure gas acting on the small area, and the low-pressure gas pushing against the larger area, a balanced condition is achieved. Triggering upsets the balance by adding slightly more pressure on the high side. As the piston starts to move, the seal is disengaged and the entire surface of the piston is exposed to the high-pressure gas supply.

A die, or punch, is mounted on a ram attached to the piston. The other die is located in the bolster. The ram smashes into the workpiece at speeds up to 200 ips. Recocking involves a hydraulic system.

• **Sock absorption**—Dynapak has a self-reacting system, similar to that used in artillery recoil. This eliminates dependence on large foundations. When the piston is released, the heavier cylinder and tie rods move slowly in the opposite direction.

The huge machine at Brake Shoe is held in place with a few bolts embedded in concrete. Installation was as simple as putting in a large drill press.

Only a small percentage of Dynapak's power is used in Brake Shoe's hot-forming experiments—35,000 ft. lbs. of the machine's maximum 431,000 ft. lbs. of energy.

A cone-shaped piston cap was formed from a 2-x-2 in. cylindrical billet of 4130 steel. The billet was first heated to 2150°F in a salt bath. Both dies sections were lubricated with a graphite and water solution to cut down heated to 2150°F in a salt bath. Both die sections were lubricated with a graphite and water solution to cut down the possibility of the hot-forged part sticking to the punch or dies.

This part was Dynapak-formed with a wall thickness of 0.180 in. and a variation of ±0.0005. Concentricity value was ±0.010. The surface finish was superior to that achieved through conventional forging methods.

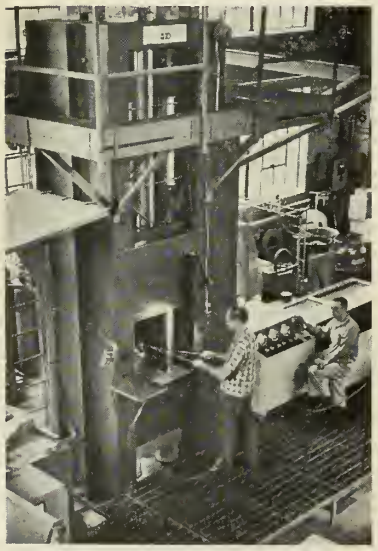
Ordinary forging practices would demand at least four press strokes and a session on a cold-trim press. Inside and outside machining would be required.

The large Dynapak proves most effective where high-cost metals must be formed in intricate shapes to extremely close tolerances. The high abrupt pressures formed within the die cavity cause severe deformations, moving the metal farther and faster than conventional processes. Tough, brittle materials exhibit a plastic behavior and flow smoothly into every die opening.

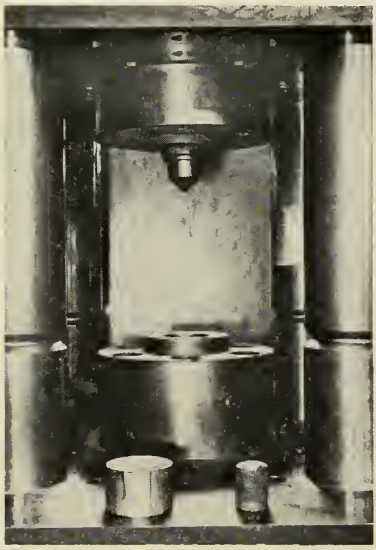
• **Productivity low** — Production rates of several hundred per hour have been reached on standard equipment. The productivity of Brake Shoe's Dynapak is restricted to its cycle time of 105 seconds. This time can be reduced considerably through a few minor modifications in the design.

The potential of Dynapak has not yet been fully determined, and present die design poses another limitation—many conventional dies do not take full advantage of the Dynapak's capability.

Brake Shoe spokesmen feel that the increased forging costs due to short run requirements would be compensated for by reduced metal costs—elimination of much, if not all, final machining—and longer fatigue life. ⌗



LARGEST Dynapak in existence is ready for production orders after months of experimentation by Brake Shoe scientists.



LEFT billet here was used in forming of steel-mill oxygen nozzle, right billet for 4130 steel piston cap.

How ARGMA Estimates Weapon Trends

Technique shows progress within a given system, awarding success where incomplete rounds attain major objectives—no 'partials'

by
A. Steinberg, E. L. Bombara and S. M. Jacks

Army Rocket and Guided Missile Agency, Huntsville, Ala.

THE ARMY Rocket and Guided Missile Agency relies on estimated reliability trends to keep track of how its weapons systems are developing toward their defined objectives.

In terms of success and failure, such trends can be a useful tool—even though the term "failure" is distasteful during a development program.

Mere scorekeeping helps to define problem areas of weak designs in subsystems, out-of-control conditions in manufacture, and human factors contributing to mission failure.

But scorekeeping alone does not produce sound reasons for design changes—it is historical by nature.

For example, when a system fails, the subsystem causing the failure can usually be identified—but it is normally impossible to determine which piece or part caused the failure.

The method of reliability trends outlined in this article should be used to show progress within a system, not to estimate specific system reliability or to compare reliability of one system with that of another.

Techniques for conducting missile-system development programs matured during the last decade. Early in this period, it appeared that a system's firing tests alone were being used to qualify design and laboratory environmental tests, and that other reliability tests were delayed in the all-out effort to launch a vehicle.

Many attempts were made to evolve a method of evaluating system test results to determine system reliability. The problem was compounded by the nature of the products tested—neither homogeneous nor of a statistical quantity.

At the end of these studies it was concluded that:

—Though the test specimens are heterogeneous, there are methods for gaining some system reliability data from small sample sizes.

—A failure must be charted as a total failure, as in statistical quality control, if a figure of fraction-defective is to be offered.

—Until a cumulative average of a large number of successes is attained from homogeneous test specimens, any success/failure ratio must be explained as a point on a reliability trend curve, not as an achieved reliability. Because design configuration changes during a development program, this figure cannot be interpreted as a specific reliability value.

• **Success defined**—A development round is a complex device that seldom has the configuration and model of the final tactical version. Even more complicated is the design of the system's test. The purpose of the test may be to demonstrate safety of explosive components, structural strength, aerodynamic stability, guidance control, or simply to determine levels of shock and vibration. If each round is graded against its own test objectives, no comparison between rounds is possible. But the reliability of the system is defined as the probability of fulfilling its mission—the only ultimate yardstick for grading.

In order to maintain continuity during the evaluation, the scorekeeping criteria are the same for all rounds in the program, even though the design configuration is heterogeneous. Sample sizes would be too small during development if only homogeneous rounds were used to establish trends. For incomplete rounds, a success is awarded if the major objective is attained, even though no opportunity existed for a test of miss-distance, kill-probability, flight control and like parameters.

A major test objective is that of subsystem performance and reliability. Minor objectives such as performance of telemetering equipment and fail-safe circuits are of no concern in determining success or failure, since these components are not to be part of the tactical vehicle.

For development tests, a tactical hold is not scored, although it is a reason to assign failure in a test of troop firings. A misfire or hangfire is a failure; the same round, if undamaged or repairable, can be scored more than once if tested again.

In many cases, success is a matter of judgment. Even with a miss-distance criterion, a miss within the range of the accuracy of the miss-distance measuring equipment is considered a success.

A "partial success"—that is, failure to achieve one primary objective but success in achieving another—is scored as a failure even with incomplete rounds. If the round does not meet all primary performance

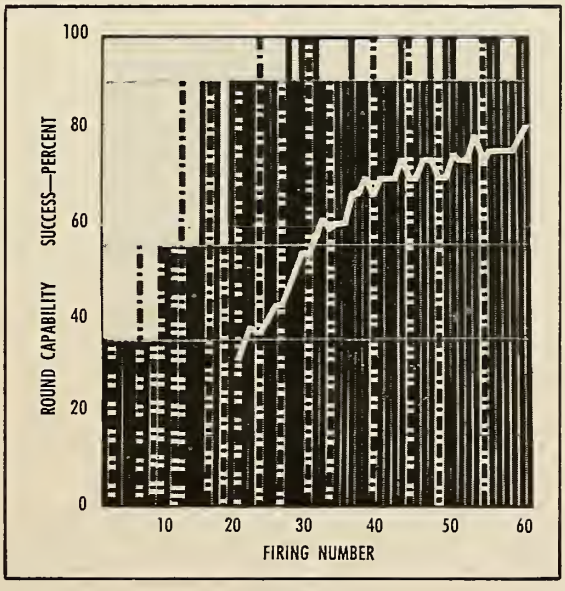


Figure 1

test objectives, it must be scored as a failure.

• **Fair weighting**—Since "partial success" is ruled out, an equitable weighting system must be used to estimate system reliability. Without weighting (multiplying by a number less than unity), the first test, being airframe and propulsion only, would usually indicate a system reliability much higher than the completed system is capable of achieving.

If reliability of an incomplete system is not weighted, 100% reliability is assumed for all untested components, which is unreasonable. Thus, the untested components must be accounted for by some weighting system whenever system reliability is computed for the purpose of showing over-all reliability trends.

Where experience in similar systems is available, the weight for each subsystem is based on the expected failure rate of that system. Then the subsystem which is expected to have the highest failure rate receives the highest weight in the computation of system reliability.

Using this method, any "breakthrough" in reliability of hitherto unsuccessful components is scored more heavily, as a contribution to high system reliability, than are previously successful components. The weighting applies only to incomplete systems.

If the system should be complete for 20 consecutive rounds, weights would no longer affect the reliability trend.

For the most part the decision on weighting is arbitrary, even though it is based on prior knowledge from similar systems. Like success, weighting is a matter of judgment.

A suggested weighting system is:

	Weight	Cumulative Weight
Propulsion	.35	.35
Autopilot	.20	.55
Guidance	.35	.90
Warhead and Fuzing	.10	1.00
Total	1.00	

Using this system, reliability of rounds capable of propulsion only can be no greater than 35%; reliability of rounds capable of propulsion and autopilot can be no greater than the cumulative weight, 55%; etc. Figure 1 illustrates a typical development program. For a time all tests are for propulsion only, and system reliability can be no greater than 35%. When autopilot is added, it can be no greater than 55%. With the addition of guidance, maximum system reliability possible is 90%. Only when the system is complete (after addition of the warhead) can reliability be 100% for the number of rounds tested.

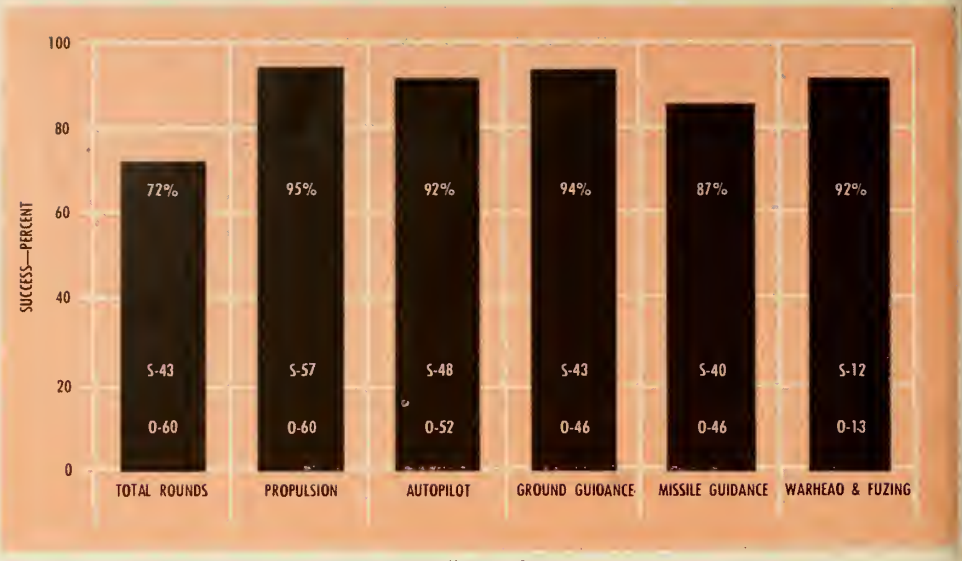


Figure 2

From round 20, a cumulative average of success is plotted based on weighted success (figure 1). A 20-round moving average is selected by compromise. A trend line on a moving average less than 20 shows rather violent movements, whereas a greater number delays indication of immediate reaction.

The desired trend would be one of gradual improvement and a final leveling-off at the capability of the system. In figure 1, this is illustrated as a system reliability with only 3 failures in the last 20 rounds plotted.

Even with the best telemetering, it is seldom that the guilty piece or part is blamed for the system failure. Parts-failure reporting is of little use during R&D testing of entire systems. But failure can be localized to the proper subsystem and the subsystem reliability estimated. This may be charted by a simple bar for each subsystem (Figure 2).

In Figure 2, the weight of the solid bar indicates the percent of success experienced by the subsystem. Note that the bar-chart breaks the guidance subsystem into 2 components, ground guidance and missile guidance. Whenever subsystem reliability is low enough so that any of the component reliabilities for that subsystem is less than 90%, it is worthwhile to show each component on the bar-chart.

Component reliabilities will always be less than subsystem reliabilities, in accordance with the multiplication theorem of probability: P overall $= P_1 \times P_2 \times \ldots P_n$. The overall system success shown in Figure 2 is $43/60 = 0.72$. The 0.81 reliability shown by the last 20-round average of Figure 1 is higher than this because it does not include the effect of problem areas that have been solved. Thus, the 20-round moving average is more meaningful.

Under the ARGMA method of scorekeeping, all systems tests are graded as success, failure, or no test. A success is defined as the achievement of the objectives of the tactical weapon, or as success of the primary test objective if the system is incomplete. Incomplete systems are weighted according to the importance of subsystems to the mission. A system trend based on a 20-round moving average is plotted after 20 test results are available. ⌗

First Minuteman Titanium Rocket Chamber Passes Test

THE FIRST second-stage titanium rocket chamber for the Air Force's *Minuteman* ICBM has been produced and hydrostatic-tested by Avco Corp.'s Lycoming Division, Stratford, Conn.

The unit is believed to be the largest rocket chamber ever fabricated of titanium and successfully hydrotested, Lycoming says. It was manufactured under a contract from Aerojet-General Corp., contractor for the second-stage *Minuteman* engine. ⌗

An Optical Sensor for Super Gyros

OPTAG I, developed by Perkin-Elmer, uses autocollimation technique for sensing gyro precession; spillover problem overcome

A HIGHLY EFFECTIVE solution o the problem of precession pickoff on xotically suspended spherical rotor yros has been developed by the Perkin-lmer Corp.

Developed for use with magnetic, lectrostatic, air-suspended or other ypes of super gyros, the new device—icknamed OPTAG (for Optical Pickoff wo Axis Gyro)—eliminates through se of the principle of autocollimation he inaccuracies inherent in standard lectrical precession pickoffs.

• **Development**—OPTAG I—an xtremely small two-axis, null-sensing utocollimator—was developed for spe-ific application to an air-bearing gyro ounting a flat mirror on its rotor nor-al to the spin axis. It resulted from company-sponsored program initiated arly this year by Perkin-Elmer.

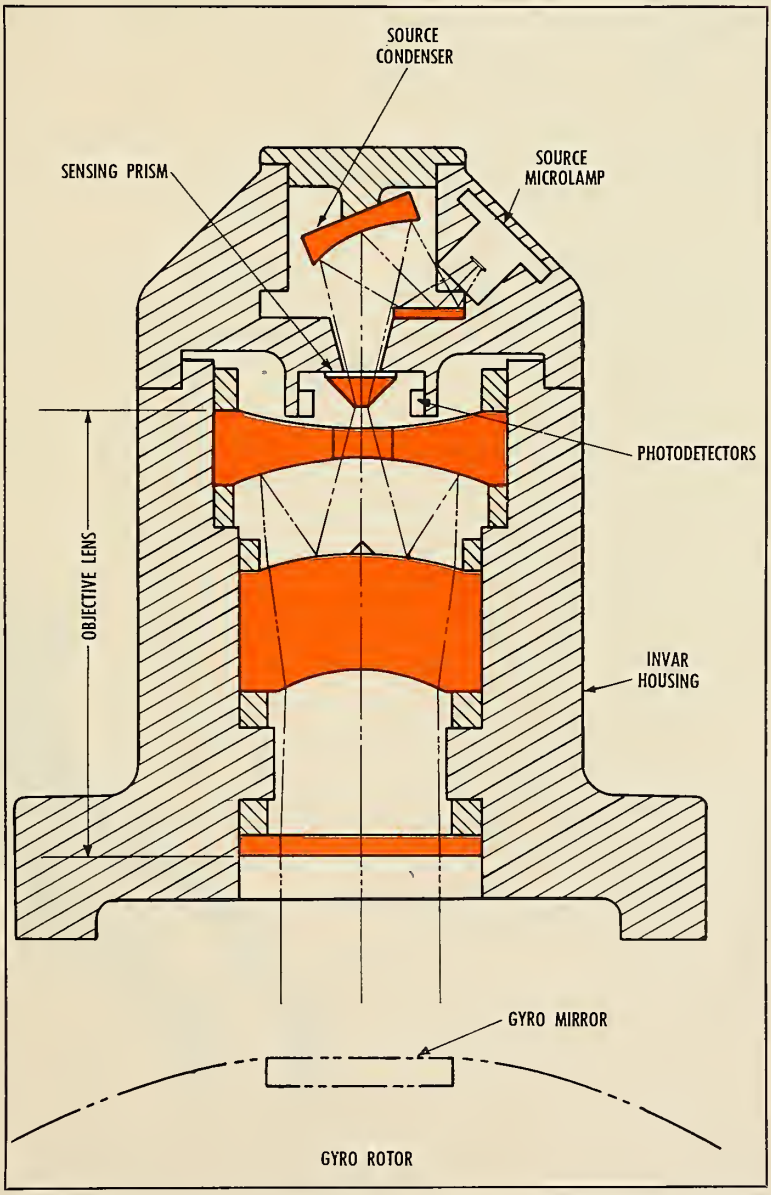
Although this particular optical de-ice has an air-bearing application, com-any officials point out that it can be dapted to other super gyros.

Development of the system required pickoff that produced little reaction orce on the gyro rotor, was compact, ghtweight and long-lived, and con-umed minimum power.

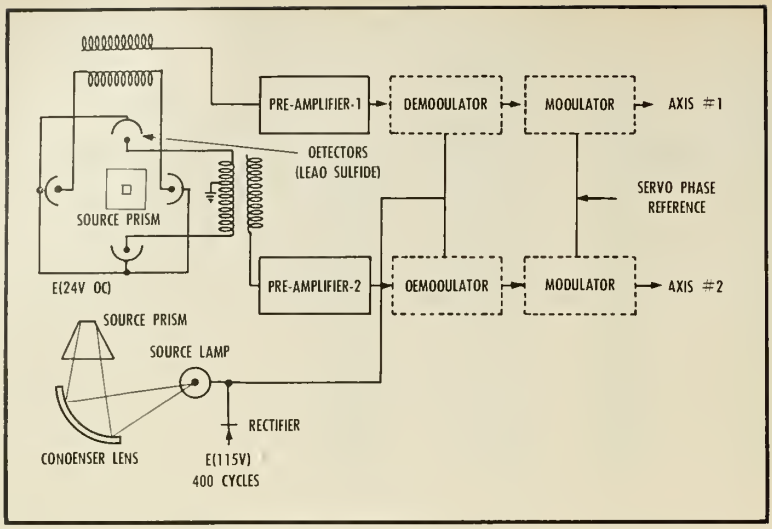
• **Functioning**—In operation, PTAG I meets these requirements by ensing light improperly superimposed n the nose of a prism and feeding these rror signals to the torquing motors of he gyro gimbals.

Specifically, the light from the lamp lament is imaged from behind on the lear nose of the sensing prism. The ose—focused at infinity or collimated y the objective lens—senses the auto-ollimated light reflected from the gyro irror.

If the mirror is not precisely normal o the optical axis, the re-imaged light ill be imperfectly superimposed on the ose. Some light, therefore, will fall on he sides of the sensing prism and be eflected into one or two of the servo etectors. The resultant error signals—mplified and applied to the torquing ervos of the gyro gimbals—serve to aintain the alignment of the gyro case ith the rotor.



CUTAWAY DRAWING OF OPTAG I shows in detail the components of the system which—using autocollimated light—provides an accurate, reliable means for monitoring precession of the most advanced gyros presently under development.



SIMPLIFIED ELECTRONICS can be achieved if the gyro and detector frequencies are identical. However, if d-c voltages or a frequency different than that of the gyro circuits are required, demodulators (or remodulators) can be used as shown.

• **Design problems**—To establish the validity of the OPTAG design, four interrelated, overlapping problems had to be investigated:

—Radiometry
—Optical Design
—Optomechanical Design
—Electronic Design

Because of OPTAG's requirements for small size, low power consumption, long life and long term stability, radiometry was clearly most critical.

Generally, an autocollimator with only one light source and two detectors for each measuring channel can be constructed. However, since the light source is also the largest, least reliable, and heaviest power source, the optimum design for OPTAG was a single source and four detectors.

• **Solid-state detectors**—The physical size of the OPTAG dictated the use of solid-state lead-sulfide photodetectors. Compatible for use with a derated tungsten filament lamp, these detectors are both standard and available in small sizes.

However, the use of lead-sulfide detectors demanded reflective lens, to provide good imagery and high transmission over the 0.5 to 2.5 micron detector sensitivity region.

• **OPTAG sensitivity**—Radiometric relations in an autocollimator are normally directly proportional to the objective lens aperture and the field angle of the light source. However, since the objective lens aperture is dictated by the gyro mechanism, the instrument sensitivity becomes solely dependent upon the source field angle.

Thus, by carefully selecting the field angle, instrument sensitivity can essentially be determined. There is, however, a limit to the gain which can be achieved by increasing the source field angle; sensitivity of the OPTAG falls off rapidly as the angle is increased above five degrees.

By fixing the source field angle at 2.5 degrees, an instrument sensitivity of better than one arc-second is achieved. This fixed angle, however, causes the source height and the objective len focal length to be interdependent.

• **Desirable focal length**—To main tain a constant source field angle o instrument sensitivity, the source imag size must increase as the focal lengtl of the objective lens increases.

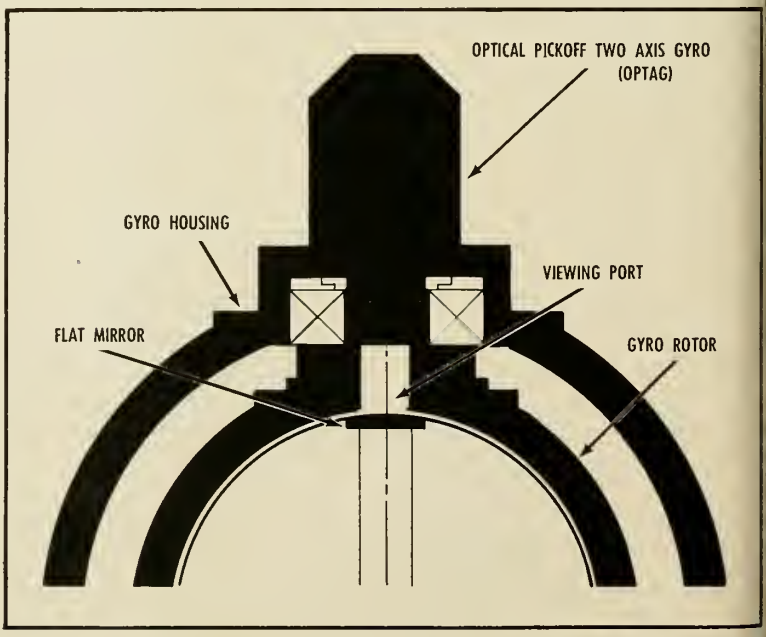
In order to achieve maximum sys tem sensitivity, therefore, the objectiv lens must be of short focal length an high speed (in order of f/2.0).

With an f/2.0 objective lens and specified clear aperture of 0.30 in., focal length of 0.60 in. is called for This, in turn, along with the 2.5 degre source field angle, necessitates a 0.02 in. height for the source lamp.

• **Source lamp**—Consisting of fou sections of coiled tungsten filament wir arranged to form a square slightl larger than the sensing prism nose (t prevent light discontinuity), the lam filament is wound in a flattened man ner. This provides the maximum amount of unidirectional radiant energ per unit of length.

The lamp—with a power input o approximately ⅜ of a watt—operate at a color temperature of 2150°K whic makes it compatible with the spectra sensitivity of the lead sulfide detectors

• **Spillover problem**—Because o the large angular diffraction pattern o small-aperature automatic autocollima tors, many seconds of light energy spil over onto the detectors at the null point.



THE OPTAG OPTICAL AXIS—mounted normal to the gyro spin axis—need only maintain a fixed angular relation to the case. This is accomplished through a Bellville spring-clamped three-point kinematic base, which maintains the angular relationship while permitting sliding between the OPTAG and gyro case.

The effect of this spillover is to make the autocollimator susceptible to null shift.

Taking into account the aperture diffraction pattern and the lead-sulfide detector characteristics, 24 seconds of light should still be incident on each detector when the OPTAG is perfectly autocollimated. This null-balanced light results in a 1.2-sec. null shift—a 10% change in reflective detector sensitivity—and also increases OPTAG instability.

To limit this instability, a highly refined lens design is needed to provide diffraction-limited imagery over the spectral region of interest. The only lens that meets this requirement and, at the same time, satisfies the field angle and f/2.0 speed, is a special flat-field Schmidt Cassegrain Catadioptric design.

• **OPTAG housing**—The necessity for long-term OPTAG stability dictated that the low expansivity quartz optics be housed in a temperature compensated cell.

Mounted in an Invar housing which has a coefficient of expansion close to that of quartz, the objective lens and sensing prism are located according to kinematic principles. Incorporating five-point mounting, these elements utilize controlled spring loading in all directions.

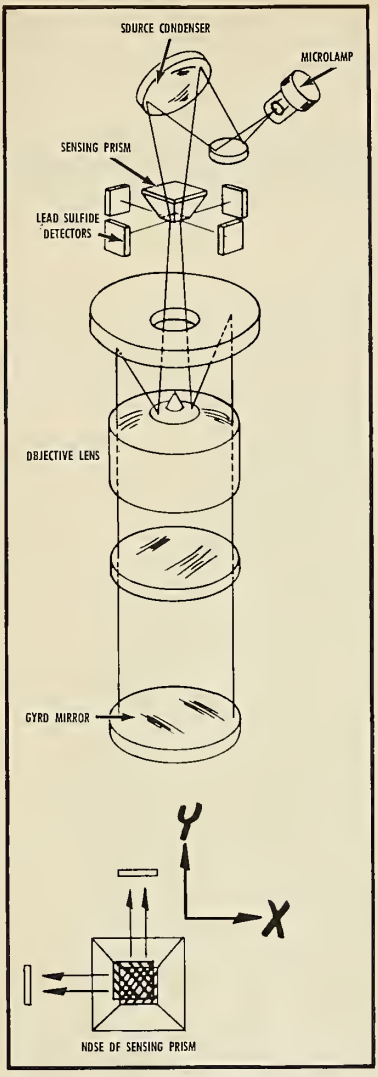
To maintain all elements in-line over a wide range of operating temperatures, the difference in expansivity between the Invar housing and the quartz optics is compensated for in the radial direction.

The difference in expansivity between the housing and the gyro case must also be compensated for. However, because it is an autocollimator, the OPTAG optical axis need only maintain a fixed angular relation to the case. This is effected by use of a Belleville spring-clamped three-point kinematic base. This permits sliding between the housing and the case but prevents angular motion between the two.

• **Electronic design**—Modulated light received from the detector causes an a-c signal to be applied to the amplifier. The opposing detector also produces an a-c signal at the same amplifier. However, because of the center-tapped transformer, the phase of this signal is reversed.

If it is practical to operate the OPTAG at the frequency of the gyro gimbal torquing servos, only the simplest followup design is necessary. Modulation of the light source from a line-energized half wave rectifier, thus obtaining a fixed phase relation between the servo reference voltage and the light source error signal, reduces the electronics to simply the lamp driver and the detector preamplifiers.

However, if the OPTAG carrier must be different than the servo frequency, or if DC is required, demodulators (or remodulators) would be necessary after the preamplifiers.



LENS SYSTEM of OPTAG I focuses light on the nose of the sensing prism and detects errors through shifts of autocollimated light. Typical error pattern—picked up by sensors—is shown at bottom of sketch.

• **Testing program**—Testing of OPTAG I began before the special tungsten light source had been completed. However, use of a mechanically chopped ribbon filament and an external mirror to provide an f/2.0 bundle, made the test setup optically equivalent to the final OPTAG I configuration.

Revealing a high level of sensitivity, the system had a resolution of better than .05 arc-seconds RMS with short-term stability of better than five seconds.

The main problem, previously discussed, was the spillover light. Measurements of the detectors at null revealed that each detector had 90 seconds of incident light instead of the prescribed 24. However, stray light—traced to the sensing prism geometry—contributed 60 seconds of light even when the autocollimated beam was blocked off.

By reducing the included angle of the prism to 80° instead of the present 90° and placing the detectors closer to the base of the prism, this problem can be solved.

• **Follow-on program**—The next version of this system—OPTAG IA—will use an f/6 objective lens and an OPTAG I source lamp and will afford a source field angle of less than one degree. The smaller field angle will allow the use of a simpler, more economical Mahsutow objective lens. Since little attention was paid to the size of OPTAG I, it is expected that the second-generation device will be smaller and lighter than the one-in.-diameter, one-and-three-quarters-in. long, nine-ounce OPTAG I.

OPTAG I was revealed at a Symposium on Optical Alignment Instrumentation sponsored by the Electro-Optical Division of Perkin-Elmer. A paper describing in detail the operation of the device was read by Sheldon Minkowitz of Perkin-Elmer. ⌗

U.S. and Britain to Build MIDAS Station in England

THE UNITED STATES and the United Kingdom have agreed to establish a MIDAS (Missile Defense Alarm System) read-out station in Northern England to give the British faster warning of an ICBM attack.

The United States has agreed to pay about $28 million of the cost of the installation, to be built at the Kirkbride RAF Station in Cumberland. Britain will provide the remaining $5.6 million to $8.4 million.

The USAF's MIDAS infrared satellite warning system, for which Lockheed Aircraft Corp. is prime contractor, will complement BMEWS (Ballistic Missile Early Warning System) in Britain's defenses. A BMEWS station is already being constructed in Fylingdales, Yorkshire.

Julian Amery, Britain's Air Secretary, told the House of Commons that the MIDAS station should provide six minutes' warning, compared with the four minutes expected from the BMEWS radar. He emphasized that the warning times in both cases were based on the worst predictable circumstances.

The U.S. will supply and install the special equipment for the Kirkbride station and its communications link with America. Britain will provide land, housing, communications equipment and pay for spare parts. ⌗

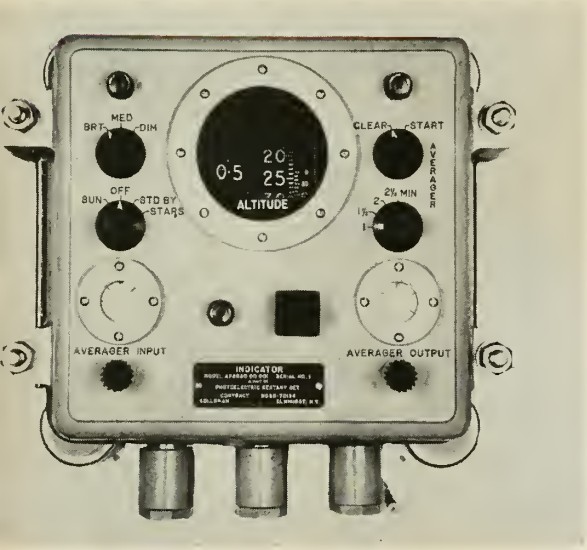
Device Seen Vastly Improving Accuracy

Kollsman scientist says use of modified aircraft tracker can yield order-of-magnitude advances; details of system

WILLIAMSBURG, VA.—Skippers navigating submarines at periscope depth could improve their accuracy by an order of magnitude by taking celestial sighting with a modified aircraft automatic tracker.

Simple analog compensation techniques can minimize the problems of periscope flexure without elaborate instrumentation.

Both the measurement technique and equipment which will do the job were described by Louis Sharpe at the annual meeting of the Institute of Navigation, held here recently.



COMPUTER-INDICATOR of Kollsman KS-100 is installed within the submarine.

Sharpe, chief of astronavigation R&D for Kollsman Instrument Corp., described the workings of the KS-100, semi-automatic Photoelectric Sextant for submarines. He described it as essentially a modification of the Kollsman KS-85 star tracker carried in the Air Force's B-57 jet bombers.

The instrument compensates automatically for hull rocking and periscope bending. Further, Sharpe said, the device can be designed to provide relative bearing measurements for true headings.

Although results are still highly classified, the KS-100 has been successfully tested aboard the Navy submarine USS Barbel.

• **Sighting an old problem**—In achieving the great accuracies needed by submarines on underwater missions, a major problem is always evident—the remoteness of sighting optics.

The problem, Sharpe disclosed, is that the stellar light (whose direction is the object of measurement) enters an optical system located just above the ocean surface. The best location for such a system would be within the hull of the boat for an inertially established vertical. It is against this vertical that stellar direction is measured.

To counteract motion atop the periscope, a gyro-stabilized platform could be employed—were it not for its prohibitive size. The method used is to bring the star direction down the scope and into the boat. There is a coordinate rotation operation, however, between deck and horizontal planes. And periscope bending action must still be counteracted.

• **Kollsman's approach**—Sharpe believes the KS-100 approach is the best and simplest answer: Locate the automatic sextant on top of the periscope and employ averaging techniques instead of stabilization. In short, Kollsman would automate the measurement-flow equivalent of a manual sextant sighting process.

Automatic star and vertical trackers would develop angles between their respective sensor directions and the instrument case. Data obtained would be star elevation-to-case and dynamic vertical-to-case (tilt measure). The difference between elevation and tilt is star altitude.

The indicated summation of sensor angles provides a result, Sharpe said, similar to the manual-sextant coincidence-sighting technique.

Tilt is effectively cancelled (the star is sensed by both trackers equally) and the altitude measurement resulting is unaffected.

As for vertical reference, he feels that periscope tilt in line with the star target can be tolerated. But, tilt components perpendicular to star direction (cross tilt) will be excessive and their influence will have to be eliminated. Thus, he said, the value of cross tilt must be measured, as well as that of in-line tilt.

• **Tracker design and operation**—The configuration of axes needed (see accompanying drawing) can be packaged within periscope diameter limits.

Sharpe said the tracker consists of the scanner combination of optics, modulator and sensor together with supporting axes of elevation and bearing. To null the scanner on its particular stellar target, pointing error signals developed by the scanner are amplified and used directly to re-orient the supporting axes.

Tilt-level sensors develop signals used to restore the corresponding axis and

f Submarines' Position Fixing

null its sensor. Sharpe said the level-sensor assembly, is, in effect, a miniature level platform with the characteristics of a damped pendulum.

Platform azimuth orientation is determined by the bearing axis, since it is shared in common with the celestial tracker.

With the KS-100 axis geometry, the engineer believes, it is possible not only to represent fairly precisely the influence of cross-tilt on celestial altitude, but to compute it simply by electromechanical means. (The quantity is equal to the square of the angle on cross-tilt axis times the tangent of the altitude registered at the output counter.) Normal potentiometer precision is sufficient, said Sharpe, since the actual value is never large for practical cases.

The only precision necessary, he feels, is in directing the star and vertical trackers. Subtraction is done simply by a differential geared to operate at multiple speed. The only trigonometric computation is the cross-tilt compensation—and this contribution is small and easily instrumented.

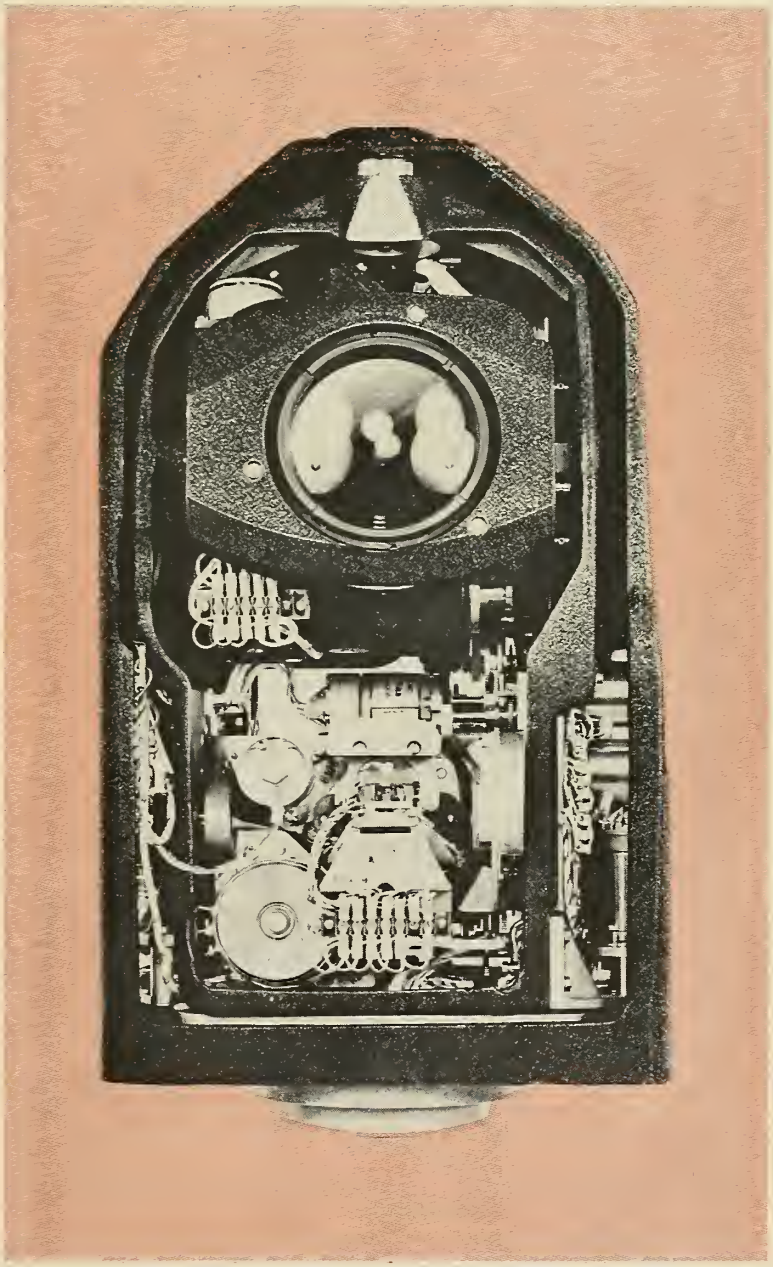
Therefore, Sharpe asserted, by combining techniques of in-line tilt cancellation and the cross-lit compensation, a periscope-mounted sextant can operate satisfactorily within the tilt conditions of its flexible support.

• **Averaging for accuracy**—for submarine use, Sharpe said, automatic celestial sightings will reflect deviations from true local vertical as high as 42.2 minutes of arc, under conditions of a state-3 sea.

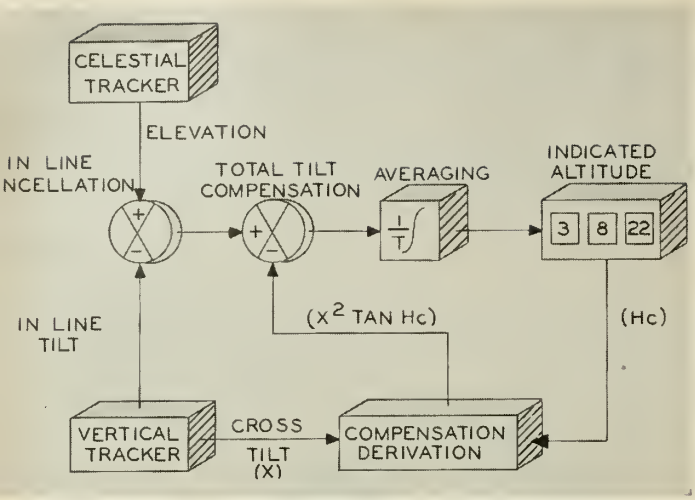
Some form of smoothing is necessary to prevent an accumulation of errors from the altitude output counter. While highly sophisticated methods of smoothing observations might be employed, Kollsman believes the simple approach to be more profitable.

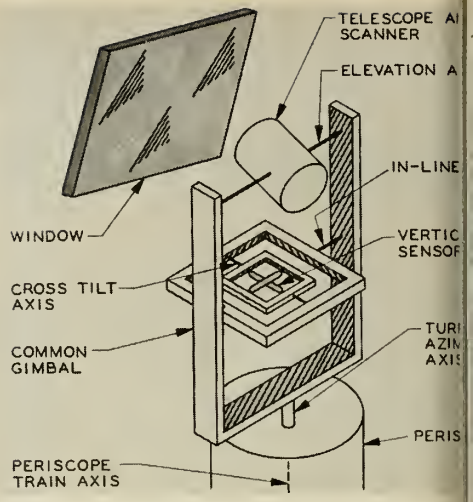
For remote averaging of celestial altitude angle, Kollsman employs an integrator that is essentially a form of tachometer servo. This unit, in the follow-up mode, keeps the output counter almost up to correspondence with the varying transmitted celestial altitude. Ideally, response is slow enough to prevent repetition of sudden variations in altitude.

Averaging completely screens out



TRACKER OF KOLLSMAN KS-100 shown with outer turret removed. The automatic photoelectric sextant was designed for use atop submarine periscopes for star tracking. Its developers say it may improve position-fix accuracy by an order of magnitude.





LEFT: *Configuration of axes for an automated tracking head. Such a system can be used to measure both cross-tilt and inline tilt for error compensation.* **RIGHT:** *Flow diagram of automated sextant providing tilt compensation, averaging of observations, and readout of computed stellar altitude. The Kollsman system has been checked at sea aboard a Navy sub.*

only certain types of variations—such as an integral number of sinusoidal cycles—said Sharpe, and remaining phase error experienced will possess a random value. However, the rms error resulting from averaging weaknesses can be calculated for a given set of conditions.

If the navigator fits his averaging interval to sea motion within ¼ roll cycle, Sharpe reported, error is reduced to 44.1 sec. of arc. The better the sea state, the more effective is the averaging process.

There are two other non-cancellable error forms, according to Sharpe, that can be eliminated by conventional sextant routines: acceleration of Coriolis and real changes in true value of celestial altitude (caused by motion of observer and earth rotation).

The first, Sharpe asserted, is predictable and thus can be computed out.

The second has change rate and constancy slow enough so that its effect can be cancelled merely by designating the center of time interval in computations as that instant for which the average value is valid.

• **Magnitude improvement**—Together with the automatic sightings, tilt compensation, and averaging, the use of multiple sightings on other stars well distributed in azimuth can provide an order-of-magnitude improvement in position fix.

The point stressed by Sharpe is that while the navigation concept is not new, its order of accuracy is unprecedented.

For example, when four stars are used for a quadrilateral of position, the figure center represents a fix whose standard deviation in latitude and longitude is reduced from a single rms by a factor of 0.875. Furthermore, index error is nearly cancelled, Sharpe said.

The KS-100 hardware consists of three separate subsystems: the tracker, computer-indicator, and control amplifier. The tracker, contained within a rugged turret, was tested as a part of a Kollmorgen Optical Co. Type 10 periscope.

Size-weight details of the KS-100 have not been released. However, as a rough indication of vital statistics, the earlier aircraft version (KS-85) employs a 16.5-lb. tracker, and measures about 7.25 in. dia. X 17.2 in. high. Total system weight is 47 lbs.

The tracker is visually assisted by the operator in locating the correct star, since training and elevation are coincident with the periscope cross-hairs.

According to Sharpe, KS-100 real-star performance has been checked on a Scorsby machine (roll, pitch, and yaw simulator) and at sea aboard the USS Barbel. Tests apparently have been satisfactory, but actual results are classified.

Sharpe stressed five other principal features of the Kollsman semiautomatic photoelectric sextant:

1. Simplicity—in concept, hardware, and computation.
2. Serviceability—tracker can be removed easily at sea.
3. Automaticity—manual skill not required during sighting.
4. Operability—star and vertical sensed at same location; periscope tilt and bend fully accommodated.
5. Practicality—tracker offers small exposure and non-interference with normal periscope functions.

The only loss exhibited by this navigational aid, according to Sharpe, is observation time. With the promise of magnitude improvement in accuracy it would appear to be more than a fair trade. ⌗

'Hardest' Tool Steel in Production

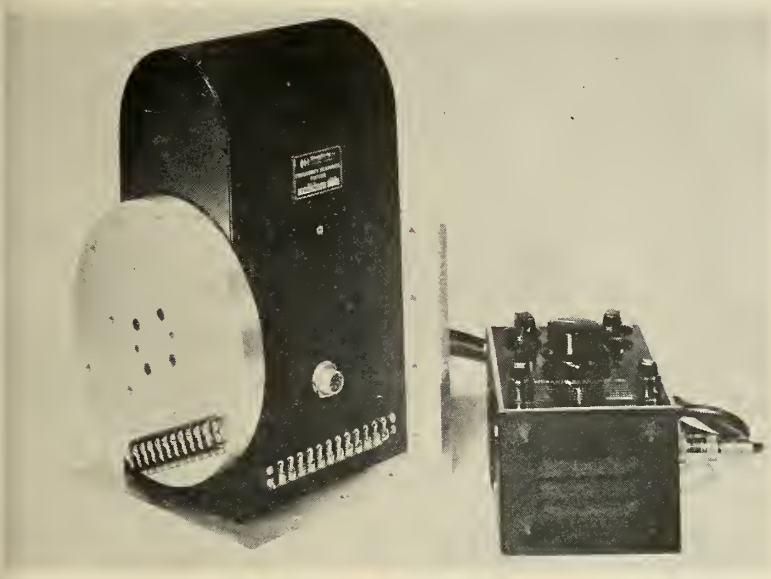
A TOOL STEEL that "approaches the hardness of a diamond" has been announced by Continental Copper & Steel Industries, Inc.

The new high-speed alloy steel, now in commercial production, will cut virtually all other known metals or alloys, according to the company, and in tests by more than 75 companies has kept its cutting edge up to 10 times as long as previous standard tool steels.

The special composition—described as containing chromium, vanadium, tungsten, molybdenum and cobalt, plus a relatively small percentage (1.15%) of carbon—was developed at the laboratories of the Braeburn Alloy Steel Division of C.C.S.I. and introduced last December for testing by the machine tool industry. The company says the price of the alloy is about the same as that of conventional high-speed tool steels.

Mortimer S. Gordon, president of Continental, declared that the material —known as Braecut—will help solve the Space Age problem of machining super-strength metals developed for missiles and satellites.

"Braecut permits machining of the newest tough alloys and steels," he said, "and thus extends the range of metals which can be used in space vehicles, missiles and other applications." He added that the new alloy "radically reduces replacement of cutting devices." ⌗



Gyro and Accelerometer Tester

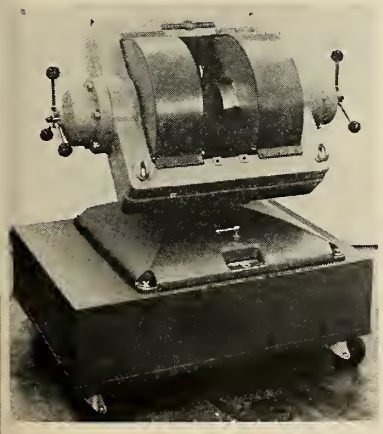
A frequency response test fixture, Model FR01, has been developed by Humphrey, Inc. The device provides for dynamic tests on rate gyros, integrating gyros and accelerometers. It will perform the same function as complex test equipment at a much lower cost. The test fixture consists of a lightweight, variable-speed turntable built on a precision right-angle mounting base.

Slip rings provide for eight connections from the base to the turntable. A remote control box provides full control. Speed range is from 1 cps to over 25 cps. A switch provided to indicate the position of the table permits phase measurements. A pot may be furnished to supply sinusoidal output in phase with the rotation.

Circle No. 225 on Subscriber Service Card

Lab Electromagnet

A 6-in. laboratory electromagnet is available from Varian Associates. Designated the V-4007-2, the 6-in. magnet features pole pieces of which the air gap width may be continuously adjusted from 1/32 to 5½ in. by means of an integral gap-adjusting mechanism. The V-4007-2 enables scientists to examine samples of widely differing sizes at many desired magnetic field strengths. It reduces the time previously needed to adjust the air gap of 6-in. magnet types. This mechanism can also be added to all Varian 6-in. rotatable magnets in use; and the owners of the new magnet can convert to fixed-pole pieces, if desired, to gain particular benefits of extremely high-field homogeneity.



Circle No. 226 on Subscriber Service Card

Precision Drive

A miniature dual speed drive designated DSD-40 is available from Technology Instrument Corp. Designed to meet the need for a low-cost miniature precision gear reducer, the DSD-40 provides a positional accuracy of 12 minutes of arc. A knurled thumbwheel actuates a screw and axially locks the outer dial securely on exact setting. It may be adapted to any of the precision packaged drives produced by TIC.

Circle No. 227 on Subscriber Service Card

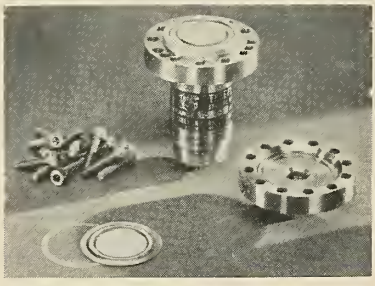
Rectilineal Potentiometer

A rectilinear potentiometer has been introduced by Hyres Electrical Division, Hydraulic Research and Manufacturing Co. Through the use of new materials, stability of the 431 Series is under 30 ppm per degree of C° to 150°C plus operating temperatures from −70° to 175°C. Available with strokes from 0.5 to 12 inches, and mounting configurations of either flange, clamp or collar. Termination is accomplished through the use of Hyres' exclusive leakproof chamber utilizing teflon leads.

Circle No. 228 on Subscriber Service Card

Airborne Transducer

Taber Instrument Corp. is marketing a miniature transducer designed for airborne applications involving the precise electrical measurement of fluid and gas pressures up to 200 psia or psig. Called "Teleflight" Model 183, it is built to withstand the severe accelerations and vibrations encountered during missile and rocket flights, while maintaining pressure-measurement accuracy of 0.25% over a wide temperature range. The measuring element is a one-piece, Ni-Span-C proving ring to which are

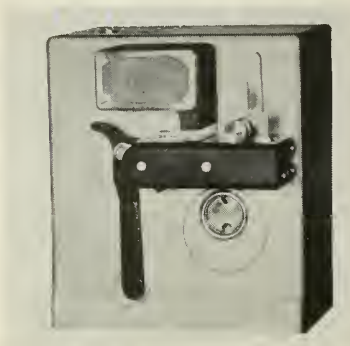


bonded four precision strain gages, forming a Wheatstone Bridge. Under zero gravity conditions, when convection cooling ceases to function, the proving ring acts as a heat sink in conducting heat from the resistance wires to the instrument case. Metal diaphragms separate the pressure cavity from the measuring chamber.

Circle No. 229 on Subscriber Service Card

Anemometer Reader

Soroban Engineering, Inc. has developed a Anemometer (hot-wire) high-speed tape reader that offers extreme reliability in high-speed tape reading at varying speeds from static to more than 500 in./sec. The Anemometer sensing elements and the feed mechanism of the Soroban GP-2 tape perforator are in-



tegrated into a single compact unit which will reliably read character-by-character, at speeds up to 300 codes per second. Tape handling is so gentle that even low-grade paper tapes have a life of hundreds of passes.

Circle No. 230 on Subscriber Service Card

Computer Equipment

A complete line of peripheral equipment for the PB250 computer is available from the manufacturer, Packard Bell Computer Corp., Division of Packard Bell Electronics. All of the peripheral units are designed for plug-in connection to the PB250 without need for accessory equipment or modification. Included in the line are magnetic tape units, a high-speed buffer, high-speed paper tape reader, high-speed paper tape punch, card reader, digital graph recorder, analog-to-digital and digital-to-analog converters, high-speed line printers, and a battery power supply.

Circle No. 231 on Subscriber Service Card

Thermoelectric Modules

Sela Electronics Co. has available the CORON thermoelectric module, whose many uses include cooling or heating of electronic systems and components, medical and laboratory equipment, and compact airborne and underwater units, as well as reliable maintenance of constant temperature. The units are available in one-, two-, four- and eight-couple modules, in encapsulated or non-encapsulated forms, and exhibit a high figure of merit and exceptional heat pumping capacity.

Circle No. 232 on Subscriber Service Card



Volt-Millivoltmeter

A portable vacuum tube volt-millivoltmeter (model 100), with accuracy within 1% has been developed by Sun Electric Corp. for laboratory and field use. The meter features 12 voltage ranges from 1 millivolt full scale to 300 volts full scale. It also has 12 DB ranges, −72 to +52 DB full-scale reading out on a 5-in. mirror scale with a knife edge pointer. It operates from either a 115 or 230 volt, 50 to 1000 cycle source and is self-protected to 600 volts.



Circle No. 233 on Subscriber Service Card

Hi-Pressure Storage Vessels

High-pressure gaseous storage vessels have been developed by The Garrett Corporation's AiResearch Manufacturing Co. The storage vessels are designed for operating pressures up to 20,000 psi. Their applications include any high-pressure gaseous use, either airborne or ground. The vessels, made of 4340 steel, have proven reliability—successfully undergoing 100 g shock tests.

Circle No. 234 on Subscriber Service Card

Weld Strength Testers

Weld Joint tensile testers have been added to the line of electronic welding equipment at the Vacuum Tube Products Division of Hughes Aircraft Co. The units are available in two models: the VTA-46, having a testing range of 0-50 lbs., and the VTA-47 with a 0-100-lb. range. Both feature a load indicator which holds the maximum specimen pull until reset. A one-to-one mechanical adjustment of the load jaws make possible quick set-ups, but actual loading is applied through a 100-1 reduction wheel. Other features of the units are a jeweled meter movement, interchangeable jaws and anti-backlash provisions to prevent surge readings at the breaking point.

Circle No. 235 on Subscriber Service Card

Salt-Spray Chamber

A self-contained, automatically controlled salt-spray chamber which assures maximum protection against salt vapors escaping from the chamber's test compartment is available from Wyle Laboratories. Heater and thermostat, which are susceptible to corrosion, have been eliminated from the salt-solution reservoir. The internal test compartment, which encloses the reservoir, is constructed entirely of fiber-glass-resin, in place of materials such as rubber, which are subject to corrosion. A water seal around the chamber's top edge prevents the salt fog from seeping out into either the machinery compartment or the atmosphere.

Circle No. 236 on Subscriber Service Card

Interference Filters

Infrared Industries, Inc. has available a new line of high-quality optical interference filters with band-pass and "spike" characteristics in the spectral region 0.38 to 0.8 microns, extending from near-ultraviolet to near-infrared. Spike filters feature bandwidths of as little as 1% of peak wavelength with 60% or better transmission of center wavelength than the nominal pass band and may be blocked to specification on the long wavelength side to reflect radiation equivalent to the spectral response of an S-4 phototube. Special filters, also available, include extremely wide-pass filters and spike filters with pass bands as little as 0.1% of center wavelength.

Circle No. 237 on Subscriber Service Card

Traveling Wave Tube

A low-noise, K_u-band traveling-wave tube amplifier with a saturated power output of 5 milliwatts is available from the General Electric Co., Power Tube Department, for use in countermeasures equipment and microwave relay systems and as the input tube in radar receivers. Designated the Z-3031, the tube has a noise figure of less than 14 db across its specified frequency range of 14-18 km. Gain is at least 25 db.

Circle No. 238 on Subscriber Service Card

Silicon Power Varactors

A series of 55 high "Q" silicon power varactors with a wide variety of breakdown voltage values from 6 volts through 120 volts is available from Microwave Associates, Inc. These diodes (MA-4351A-G through MA-4358A-F) are said to provide unprecedented high-efficiency harmonic generation and are recommended for applications in the 1 mc to 40,000 mc region. The subminiature "pill" case featuring axial prongs for convenient mounting in strip-transmission-line or other circuits, represents a novel case style with unique advantages for the user. One of the prongs may be removed so that the case can be mounted upon tapped posts. This is especially convenient for mounting within miniature cavities as in microwave harmonic generators and cavity tuning applications.

Circle No. 239 on Subscriber Service Card

High-Voltage Capacitors

A line of encapsulated high-voltage miniature capacitors is being produced by Dearborn Electronic Laboratories, Inc. Designated the EF Series, these miniaturized units reportedly feature all the electrical characteristics of glass

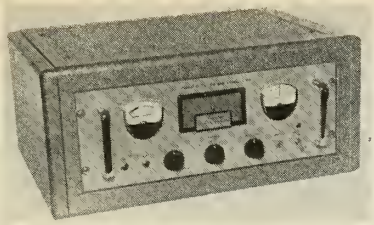


tubulars without any of the accompanying inherent mechanical weaknesses. EF capacitors also have the same environmental characteristics as the larger CP-70 series capacitors, without their bulk and weight. Encapsulated in epoxy resin, they are impervious to shock, vibration, fungus and corrosion —as well as vacuum and/or pressure effects. They exceed requirements of MIL-C-25C.

Circle No. 240 on Subscriber Service Card

VLF Timing Receiver

A solid-state VLF timing receiver and correlator, offering front panel selection of the major VLF standard frequency stations, is available from Interstate Electronics Corp. The receiver, IEC Model 400, may be used, through front panel selection, at 16, 18, or 20 kc for reception of stations GBR, Rugby, England; NBA, Balboa, Canal



Zone; and WWVL, Sunset, Colo. The signal selected is automatically correlated with a signal derived from a local standard by means of the internal regenerative divider circuitry, giving an output of approximately one cycle each fifty seconds for a one part in one million frequency difference.

Circle No. 241 on Subscriber Service Card

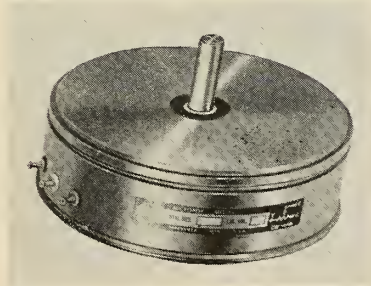
Crucible Pot Furnace

An electric crucible pot furnace with atmosphere retort and forced-air cooling pit has been added to the line of equipment for production of semiconductors, solid-state and other electronic devices of Lindberg Engineering Co. This Type RDPC-77 Lindberg Furnace is rated at 2250°F (1232°C) maximum chamber temperature. Atmosphere retort with a clear working area of 4.5-in.-diameter by 6.5-in.-deep can be used to 2150°F. Rapid cooling of the retort is obtainable with a non-insulated forced-air cooling pit.

Circle No. 242 on Subscriber Service Card

200K Ohm Micropot

Borg Equipment Division, Amphenol-Borg Electronics Corp. is marketing a series of single-turn micropot potentiometers with a standard resistance range of from 100 ohms to 200,000 ohms. The resistance element is wirewound, featuring certified resistance alloys wound on thermosetting cards. Maximum power rating is 6 watts at 40°C. Gangable up to 8 units on a common shaft, the 2490 is designed to



withstand the higher temperature ranges up to 125°C. Housings and mounts are aluminum for maximum heat dissipation. Servo, bushing or tapped-hole mounts are available.

Circle No. 243 on Subscriber Service Card

new literature

EPOXY RESINS—Significant data on high-temperature properties of Oxiron epoxy resins and on the potential of these materials in laminate applications are reported in a technical bulletin published by the Epoxy Department of Food Machinery and Chemical Corp. The six-page bulletin, which covers findings from the latest studies of FMC's eposidized polyolefins, presents information on promising Oxiron resin uses in wet lay-up, prepreg, and printed circuitry laminate applications. Various Oxiron curing systems that have been found to give materials excellent high-temperature properties are also discussed.

Circle No. 200 on Subscriber Service Card

INSULATIVE SILICONES—An 8-page publication "Silicones for Electrical Insulation," is available from the Silicone Products Department of General Electric. Designated CDS-288, the publication is complete with more than 20 photographs and charts providing valuable data and examples of silicones in use in a wide variety of electrical and electronic application. Included are sections on silicone varnishes for impregnating and protective coatings, clear and opaque potting and encapsulating materials, pressure sensitive adhesives, dielectric fluids, dielectric greases, wire and cable insulation and combination constructions of silicones with other materials.

Circle No. 201 on Subscriber Service Card

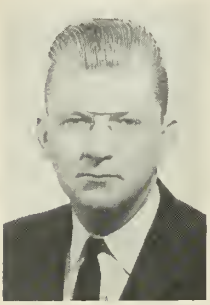
LIMITED WAR—Planning Research Corp. has released a 24-page pamphlet on the role of planning and analysis in meeting the challenge of limited war. The pamphlet outlines representative problem areas in the following broad categories: transportation and supply; surveillance and reconnaissance; communications and data processing; weapons and weapons systems; air defense; special warfare; and economics of limited warfare. A resume of PRC experience, including some typical projects, in problems of limited war also is included.

Circle No. 202 on Subscriber Service Card

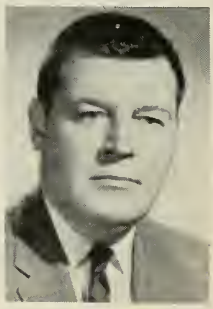
GLASS BONDED MICA—Electronic Mechanics, Inc. has published literature detailing new information on MYKROY glass-bonded mica as a high frequency insulator. The literature presents the data assembled in extensive tests on MYKROY 750 and MYKROY 1100, which conform to MIL-I-10A-L443 and MIL-I-10A-L442 respectively. The tests established the two grades as excellent low loss insulators at high frequencies.

Circle No. 203 on Subscriber Service Card

names in the news


BOGGS


TYSON


SMITH


MUSHRUSH


BREITWIESER

Dr. Samuel Koslov: Appointed assistant head of the Department of Physics and Space Sciences at Vitro Laboratories, West Orange, N.J. Prior to joining Vitro, Dr. Koslov was associate professor of physics at Stevens Institute of Technology.

D. C. Wolford: Formerly with Westinghouse Electric International Co., joins Temco International Corp., Washington, D. C., as director of technical operations.

Gail E. Boggs: Promoted to director of research and development, Page Communications Engineers, Inc., Washington, D.C. Before joining Page, a subsidiary of Northrop Corp., Boggs was head of the Time-Division Multiplex Section in the Department of Defense.

R. G. Fisher and **I. H. Moore:** Named project managers for the *Dyna-Soar* and Boeing 707 aircraft electric system programs at Westinghouse Aerospace Electrical Dept., Lima, Ohio.

Bert Fleming: Named senior manufacturing engineer, electro-mechanical devices, in the Military Electronics Division of Daystrom, Inc., Archbald, Pa. **Donald S. Taylor** joins the division as development engineer.

Dr. Grant S. Bennett: Appointed chief scientist-acoustics, Chrysler Corp.'s Missile Division, Detroit, to direct the division's expanding activities in underwater acoustics research and development. Prior to joining Chrysler, Bennett was supervisory physicist at Bendix Corp.'s research laboratories.

William F. Parker: Named vice president, program management, North American Aviation's Space and Information Systems Division, Downey, Calif. Parker also heads the division's *Saturn S-II* booster proposal effort. **Dr. Clifford E. Weber** named director of fuels and materials at Atomics International Division of NAA; **W. F. Snelling** appointed executive vice president, **Gary Stroh,** manufacturing vice president, at NAA's Los Angeles division.

Dr. Andrew Herczog: Promoted to senior research associate in electronics, Corning Glass Works, Corning, N. Y.

John W. Boone: Former vice president of Radiation, Inc., elected to board of directors, Airpax Electronics, Inc., Ft. Lauderdale, Fla.

Owen A. Tyson: Appointed director of newly-formed Microwave Electronics activity in Quantatron's Microwave Laboratories, Santa Monica, Calif., where he will be engaged in development and engineering design of solid-state devices for microwave applications. **E. O. Bowers,** associated with Tyson in this work, is responsible for applications engineering in parametric amplifiers and other solid-state devices.

John Ohman: Former head of Physics Laboratory, Melpar's Applied Science Division, appointed head, Physical Sciences, Bay State Electronics Corp., Boston.

Dr. Maurice L. Torti: Promoted to director of metallurgical research, Metals Division, National Research Corp., Cambridge, Mass. **Richard W. Douglass,** previously with Battelle Memorial Institute, joins NRC as metallurgist.

Arnold H. Smith: Named director of quality assurance, Military Systems/Stavid Division, Lockheed Electronics Co., Plainfield, N.J. Smith was formerly supervisor for reliability technical support with The Martin Co.

Roy S. Mushrush, Jr.: Formerly in Heavy Military Electronics Dept., appointed manager of General Electric's new Engineering Operation in the Defense Systems Dept. **Robert G. Henry** named manager of the Marketing Operation, succeeding **Warner R. Sinback,** who is now manager of the Information and Control Systems Product Section, DSD.

Dr. Charles J. Breitwieser: Co-founder and director of Cubic Corp., San Diego, elected executive vice president and general manager.

Dr. F. Joachim Weyl: Appointed Deputy Chief and Chief Scientist of the Office of Naval Research, Washington, D. C., replacing **Dr. Thomas J. Killian,** who has resigned to accept a position in private industry.

Philip M. Prophett: Named manager of Base Activation at General Dynamics/Astronautics, San Diego, Calif., where he will be responsible for setting up the complete weapon system for the Strategic Air Command's operational *Atlas* missile. Prophett succeeds **A. P. Higgins,** who became vice president of The Hayes Corp., Birmingham, Ala.

Dr. Harold H. Sheldon: Appointed director of research and development and a member of the board of directors, Bristol Dynamics, Inc., Brooklyn, N.Y.

Dr. Charles W. Walton: Promoted to vice president for research, Minnesota Mining & Manufacturing Co., St. Paul.

Drs. Robert L. Hubbard and **Edgar R. Terry:** Join the Operations Evaluation Group of Massachusetts Institute of Technology as members of the Washington, D.C., research staff. OEG conducts operations analysis for the Office of the Chief of Naval Operations.

Dr. Kazuo A. Yamakawa: Joins Electro-Optical Systems, Inc., Pasadena, Calif., as head of the Materials Research Dept. of the Quantum Physics Division. Prior to joining EOS, Dr. Yamakawa was with Hughes Research Laboratories.

James F. McGee: Appointed chief of the Systems Test and Operation Section, Jet Propulsion Laboratory, California Institute of Technology, Pasadena. McGee replaces **Dr. Norman F. Jacobson,** named chief of the Program Engineering Section.

H. Eugene Crow Jr.: Formerly with Dage Div., Thompson Ramo Wooldridge, Inc., named manager of television systems for Cohu Electronics, Inc., Kin Tel Division, San Diego, Calif.

Harold D. Kube: Elected to Frederick Research Corp.'s board of directors, Wheaton, Md. Kube also is treasurer of Jansky & Bailey, a division of Atlantic Research Corp., Alexandria, Va.

Robert J. Veale: Former senior staff engineer, appointed manager of radar applications engineering at Hughes Aircraft ground systems group, Fullerton, Calif.

contracts

NASA

28,000—**Electronics Communications, Inc.**, St. Petersburg, Fla., for research and development and design of package for *Saturn* flight control computer.

stro-Electronics Div. of Radio Corp. of America, Princeton, N.J., from Marshall SFC, for development of a payload capsule for flight-testing electric propulsion engines. No amount disclosed.

MISCELLANEOUS

225,000—**Networks Electronic Corp.**, Chatsworth, Calif., from **ACF Industries, Inc.**, Paramus, N.J., for highly sensitive, infrared dewar detectors.

adio Corp. of America, New York City, from **Lockheed Missile and Space Co.**, for construction and installation of an automatic programer and test system (APATS) for monitoring and testing of satellites in an environmental chamber.

NAVY

300,000—**Atlantic Research Corp.**, Alexandria, Va., from ONR, for production of *Arcas* sounding rocket.

125,000—**Varo, Inc.**, Garland, Tex., for production of missile-borne hot-gas turbogenerator power units for *Sidewinder* missiles.

78,099—**Vickers, Inc.**, Waterbury, Conn., for solid-propellant starting system.

ystems Div., LFE Electronics, a group of **Laboratory for Electronics, Inc.**, Boston, for production of analog computer modules for use in *Polaris* submarines. No amount disclosed.

ARMY

9,435,032—**Western Electric Co., Inc.**, New York City, for 12 partial sets of *Nike-Hercules* ground equipment.

4,900,000—**Fairchild Stratos Corp.**, Hagerstown, Md., for continued work on *AN/USD-5* surveillance drone system.

1,040,131—**Raytheon Co.**, Waltham, Mass., for concurrent repair parts, *Hawk* missile system. (2 contracts)

982,458—**Eclipse-Pioneer Div., Bendix Corp.**, Teterboro, N.J., for special test and checkout equipment for *Pershing* guidance and control assembly.

605,800—**PRD Electronics, Inc.**, Brooklyn, N.Y., for design and construction of a prototype microwave calibration test set 200 to 40 kmc, and 8 additional sets.

343,560—**Western Electric Co.**, New York City, for research and development of the *Nike-Zeus (Nike II)* guided missile system.

183,000—**RCA's Surface Communications Div., Defense Electronic Products**, Camden, N.J., for study to develop a maintenance and logistics program for micromodule equipment.

98,000—**Martin Co.**, Orlando, Fla., for preliminary models for evaluation and test purposes of private radio-telephone system (RACEP) capable of handling scores of subscribers over a single-frequency channel virtually interference-free.

90,000—**Arthur D. Little, Inc.**, Cambridge, Mass., for development of pyrolytic refractory materials for solid-fuel rocket motor application.

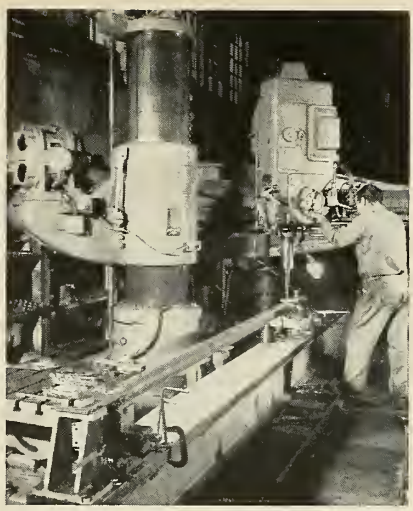
AIR FORCE

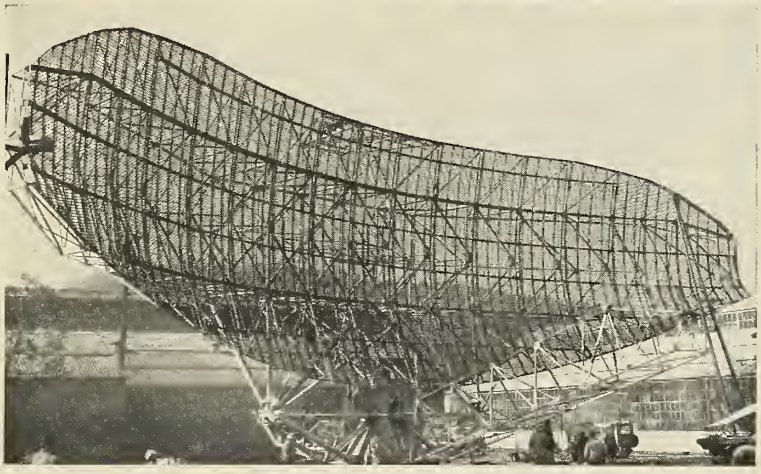
3,343,395—**Douglas Aircraft Co.**, Santa Monica, Calif., for modernization of facilities for use in work on *Skybolt* missile.

2,300,000—**General Dynamics Corp., Astronautics Div.**, for maintenance on end items and components of *SM-65 Atlas* airframe and associated ground equipment; $1,081,000 for *Atlas* system integration and in-service engineering.

(Continued on next page)

SKILL HERE MEANS ACCURACY HERE





U.S.A.F.'s FPS-35 Radar Antenna, built for Sperry Gyroscope Co.

Blaw-Knox skill in fabricating intricate structures to close tolerances makes possible even greater accuracy in the operation of radar antennas, tracking antennas or radio telescopes. Highly developed manual skills and skillful operation of machine tools assure better fit in these large, but extremely precise instruments.

It is the master-craftsman skills at Blaw-Knox, plus Blaw-Knox's unique shop facilities and years of fabricating experience, that produce close-tolerance instruments. And Blaw-Knox engineering skills assure the right design to make the best use of those facilities and that experience.

Blaw-Knox designs and produces antennas to close tolerances with minimum deflections at reasonable cost — fabricates in steel, special alloys and aluminum — designs to your needs or builds to your specifications. Complete research, engineering, testing and fabricating facilities are at your disposal. Write or phone for immediate attention. Blaw-Knox Company, Pittsburgh 38, Pennsylvania. Phone STerling 1-2700.

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ANTENNAS

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An Invitation to • • •

PHYSICISTS
MATHEMATICIANS
AND ENGINEERS

from ▪ M.I.T.



The Laboratory's staff of over 1000 under the direction of Dr. C. Stark Draper is engaged in the conception and perfection of completely automatic control systems for the flight and guidance of missiles and space vehicles. Its achievements include the Navy Mark 14 Gunsight, the Air Force A-1 Gunsight, Hermetic Integrating Gyros (HIG), and the Ship Inertial Navigation System (SINS). The Laboratory developed basic theory, components and systems for the Air Force THOR and, later, the TITAN missile.

The Laboratory also developed the Navy's POLARIS guidance system. Studies for NASA are currently being carried out.

• Graduate courses may be taken for credit while earning full pay.

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- POWER SUPPLIES AND MAGNETIC AMPLIFIERS
- DIGITAL AND ANALOG COMPUTERS
- ELECTRO-MECHANICAL COMPONENTS
- TRANSISTOR CIRCUITRY AND PULSE CIRCUITRY
- RESEARCH, DESIGN AND EVALUATION OF GYROSCOPE INSTRUMENTS
- COMPUTER PROGRAMMING AND SIMULATOR STUDIES
- OPTICS, ASTRONAUTICS AND MANY OTHER AREAS

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★ All qualified applicants will receive consideration for employment without regard to race, creed, color or national origin.

. . . contracts

$1,750,000—**Hurletron, Inc., Wheaton Engineering Div.**, Wheaton, Ill., from **RCA**, for electronic timing devices for *Atlas* missile. $2,250,000 from **Hallamore Electronics Co.** for timing devices for *Atlas*.

$882,600—**GE's Missile and Space Vehicle Dept.**, Philadelphia, for development of aerospace test capsule for testing a 50-watt fuel cell battery.

$423,967—**RCA's Aerospace Communications and Control Div., Defense Electronic Products**, Burlington, Mass., from **Rome Air Development Center**, for design and study of feasibility of a simulation testing facility under the DOD Radio Frequency Compatibility Program.

$379,700—**Boeing Co.**, Seattle, for investigation of propellant system optimization.

$287,000—**Institute of Science & Technology of Univ. of Michigan, Ann Arbor**, for investigation of ways of protecting aircraft and space vehicles from destruction by hostile missiles.

$248,000—**United Aircraft Corp., Research Laboratories, E. Hartford, Conn.**, from **AFSC**, for design development and testing of an ion engine.

$200,000—**Martin Co.**, Denver, for direct support/real property installed equipment operational spare parts, special tooling and test equipment for *Titan II* bases.

$173,608—**Missiles Systems Corp.**, N. Hollywood, Calif., for spare parts for after launcher harness and forward missile launcher.

$100,000—**United Aircraft Corp.**, from **OAR**, for continued basic research in the physics of accelerating the particles in an ion beam under neutral conditions.

$93,694—**Lockheed Electronic Co.'s Military Systems Stavid Div.**, Plainfield, N.J., for procurement of 20 radar systems (X-band radar augmenters) for installation in supersonic missile targets.

$76,000—**Astronautics Div., Chance Vought Corp.**, Dallas, for investigation of requirements for a system to detect or predict an emergency situation in a spacecraft and react in thousandths of a second to initiate escape and save the astronaut.

REQUESTS

The National Aeronautics and Space Administration, Goddard Space Flight Center, Greenbelt, Md., has issued a request for Proposal No. GS-3646 for the Design and Construction of a 12-ft. x 15-ft. Space Environmental Chamber Facility which shall be a totally integrated facility housed in a section of the Payload Test Facility Bldg. 7, Goddard Space Flight Center, Greenbelt, Md.

The space environment chamber shall provide capabilities for recreating or simulating the effects of the thermal-vacuum environments and evaluation of spacecraft, spacecraft subsystems, and associated testing equipment. The facility shall permit test items to be mounted within a vessel 21 feet in diameter by 15 feet high and subjected to environmental exposure by (A) radiant heating and cooling the test item in a high vacuum by means of a thermal conditioning wall—(B) radiant heating and cooling the test item in high vacuum by means of a solar simulator and a heat sink at liquid nitrogen temperatures. Proposals are due to be received at the NASA Procurement Office, Goddard Space Flight Center, Greenbelt, Md., by August 7, 1961.

The following firms have been invited to participate: NRC Equipment Corp., Attn: John V. E. Hansen, Newton 61, Mass.—F. J. Stokes Corp., Attn: David E. Stokes, Philadelphia 20, Pa.—Adache Associates, Inc., Attn: William J. Alvarez, Cleveland 4, Ohio—Flui Dyne Engineering Corp., Attn: J. Leonard Frame, Minneapolis, Minn.—Wyle Manufacturing Corp., Attn: J. A. Sneller, El Segundo, Calif.—Webber Mfg. Co., Inc., P. O. Box 217, Attn: Robert C. Webber,

Circle No. 8 on Subscriber Service Card

Indianapolis 6, Ind.—Alpha Electric Refrig. Co., Attn: Charles E. Earl, Detroit 3, Mich.—International Radiant Corp., Attn: Karl D. Klein, New York 55, N.Y.—Westinghouse Electric Corp., Attn: William Duncan, Washington 6, D.C.—The Elec. Totpack Co., Inc., Attn: Arnold S. Mann, Philadelphia 35, Pa.—Conrad, Inc., Attn: Charles F. Conrad, Holland, Mich.—Consolidated Vacuum Corp., Attn: Lionel B. Buarcks, Arlington 1, Va.—Tenney Engineering, Inc., Att: Monroe Seligman, Union, N.J.—Catalytic Construction Co., Attn: Victor C. Quakenbush, Philadelphia 2, Pa.—Bethlehem Foundry & Machine Co., Attn: Bernard Friedman, Bethlehem, Pa.—Nooter Corp., P. O. Box 451, Attn: Mr. Robert H. Harper, St. Louis 66, Mo.—American Optical Co., Attn: Joseph Kalla, Pittsburgh 6, Pa.—Aerojet-General Corp., Aetron Div., Attn: Bryant Moore, Covina, Calif—American-Marietta Co., Guardite Co. Div., P. O. Box 188, Attn: John M. Baer, Wheeling, Ill.—United Engineering & Construction Co., Philadephia, Pa. — Minneapolis-Honeywell Regulator Co., Duarte Development Laboratory, Duarte, Calif.—Radio Corp. of America, Attn: F. C. Weisback, Lancaster, Pa.—Varion Associates, Palo Alto, Calif.—High Vacuum Equip. Corp., Attn: William E. Sprague, Hingham, Mass.—Pittsburgh-Des Moines Steel Co., P. O. Box 3459, Attn: C. R. Ford, Baltimore 26, Md.—Chicago Bridge & Iron Co., Attn: S. L. Luca, Philadelphia 3, Pa.

NASA suggests that small business firms or others interested in subcontracting opportunities on this procurement make direct contact with the above firms.

* * * *

The National Aeronautics and Space Administration Procurement & Contracts Office, George C. Marshall Space Flight Center, Huntsville, Ala., has issued a request for Proposal No. TP 2-83018 to Design and Fabricate a Telemetry Pre-Detection Recording System which will receive telemetry information from a vehicle in space flight and convert the RF signal as received to a frequency that can be recorded. Play-back of signal will be converted back to an intermediate frequency suitable for insertion into the IF amplifier of the receiver and then demodulated by the receiver.

The work under this request shall be performed in three phases: Phase I: Preliminary Design and Selection of Commercially Available Components; Phase II: Procurement and Modification of Components and Finalizing Design and Fabrication of other required components; Phase III: Assembly and Check-out of Completed System and System Compatibility Test at the Center.

Proposals are due to be received at NASA P&C Office, George C. Marshall Space Flight Center by 7 Aug. 61.

The following firms have been invited to participate: Motorola, Inc., 1120 Connecticut Ave., Washington 6, D.C., Suite 1120—Lockheed Electronics Co., Highway 22, Plainfield, N.J.—Molectronics, 6344 Arizona Circle, Los Angeles 45, Calif. — Radiation, Inc., Melbourne, Fla.—A C P Electronics Div., Riverdale, Md.—Servomechanisms, 12500 Aviation Blvd., Hawthorne, Calif.—Ford Instrument Co., 31-10 Thomson Ave., Long Island City 1, N.Y.—Cook Electric Nuckedyne Div., 3412 River Road., Franklin Park, Ill.—Vought Astronautics Div., Chance Vought Corp., P. O. Box 5907, Dallas, Tex.—Telecomputing Corp., Electronic Systems Div., 2700 Memorial Parkway, Huntsville, Ala.—RCA Astro Electronics Div., Defense Electronic Products, Princeton, N.J.—The Bendix Corp., Bendix Pacific Div., 11600 Sherman Way, North Hollywood, Calif.—Ecra Inc., Decatur, Ga.—Daystrom, Inc., 2917 Sanderson Rd., Knoxville, Tenn.—Texas Instruments, Inc., 6000 Lemmon Ave., Dallas 9, Tex.—Chrysler Corp., Missile Div., 1312 Meridian St., North Huntsville, Ala.—and Data Control Systems, East Liberty St., Danbury, Conn.

NASA suggests that small business firms and others interested in subcontracting opportunities on this procurement make direct contact with the above firms.

when and where

AUGUST

Space Age Astronomy, symposium sponsored by Douglas Aircraft Co., CalTech, Pasadena, Aug. 7-9.

American Rocket Society/Stanford University, Guidance, Control and Navigation Conference, Stanford University, Palo Alto, Calif., (Some sessions classified), Aug. 7-9.

Society of Photographic Instrumentation Engineers, Sixth Annual Technical Symposium, Ambassador Hotel, Los Angeles, Aug. 7-11.

Fourth Annual Institute on Missile Technology, sponsored by University of Connecticut and Air Force Air Research and Development Command, University of Connecticut, Storrs, Aug. 7-18.

Survival in the Nuclear Age-Executive Management Seminar, Pennsylvania State University, University Park, Aug. 13-18.

International Astronomical Union, 11th General Assemhly, Pasadena, Calif. Aug. 15-24.

American Rocket Society International Conference on Hypersonics, Compton Lecture Hall, Massachusetts Institute of Technology, Cambridge, Aug. 16-18.

National Naval Aviation Meeting, Institute of the Aerospace Sciences, San Diego, Calif., Aug. 19-24.

Welded Electronic Packaging Association Symposium, Lockheed Missiles and Space Co.'s Palo Alto Research Facility, Calif., Aug. 21.

National Academy of Sciences 10th Pacific Science Congress, University of Hawaii, Honolulu, Aug. 21-Sept. 8.

Western Electronics Show and Convention (WESCON), Cow Palace, San Francisco, Aug. 22-25.

American Rocket Society Fourth Biennial Gas Dynamics Symposium, cosponsored with Northwestern University Technological Institute, Evanston, Ill., Aug. 23-25.

American Institute of Electrical Engineers, Pacific General Meeting, Salt Lake City, Aug. 23-25.

AFOSR Sixth International Conference on Coordination Chemistry, sponsored with American Chemical Society, Wayne State University, Detroit, Aug. 27-Sept. 1.

American Society of Mechanical Engineers 1961 West Coast Conference of Applied Mechanics, University of Washington, Seattle, Aug. 28-30.

ASME and AIChE International Heat Transfer Conference, New Developments in Theory and Practice, University of Colorado, Boulder, Aug. 28-Sept. 1.

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editorial . . .

The Great Tushino Stampede

THIS WILL NOT be a very popular view but it must be said. We find ourselves thoroughly disgusted with the completely predictable and Pavlovian response to the Tushino airshow of the U.S. Air Force, some members of Congress and certain editorial writers.

It is a callous "gimme more money" scramble which casts considerable doubt on the responsibility of some of our military and Congressional leaders.

We cannot buy the picture of a thoroughly startled Air Force finding itself obsoleted by the appearance of a few Russian aircraft. Don't believe for a minute that our intelligence has been that bad. There have been too many hypocrites on public display since Tushino.

Take the statement of Sen. Goldwater, who holds the rank of general in the Air Force reserve. Apparently chilled by the appearance of the Russian bombers, he tells us the U.S. has "no fighter force worthy of the name."

Somebody has voted a lot of money for such aircraft as the McDonnell F-101 and Convair F-102 and we don't recall any previous statements from Sen. Goldwater to the effect that this money was wasted.

The nation's defense spending should be based on a reasoned assessment of what is necessary to do the job, not on hysterical or hypocritical "me-tooism."

We don't see why the "revelation" that the Soviet Union now has fighters armed with air-to-air missiles which are capable of shooting down our bombers becomes a strong argument for buying more obsolescing B-52's. It would seem to us to be a stronger argument for buying missiles which those interceptors cannot shoot down. Or perhaps for funding that long-endurance aircraft equipped with stand-off air-to-surface missiles to which Secretary McNamara keeps referring.

Or it might seem that the appearance of Russian bombers at Tushino would support a strong case for revival of the F-108, salvage of the sharply-cut *Bomarc B* program, or purchase of additional *Nike-Hercules*. Yet, with the exception of a brief lament for the F-108, there has been no loud outcry for any of this.

Why not? Why has all the shouting been for additional B-52 procurement and a step-up in the B-70 program? Could it be because Congress already has provided $448 million in new obligational authority for long-range bombers which Defense Secretary McNamara indicated he did not intend to use? Perhaps we are too cynical.

But let it be made clear. Very little was shown at the airshow in Moscow which we did not know about or could not have anticipated. To use the Soviet fly-over as a lever for unwise spending is irresponsibility of the worst kind.

WE ARE ENGAGED in a cold war with the Soviet Union—which implies economic as well as military competition. If we allow ourselves to be stampeded into spending funds unwisely, the Russians score a decisive if not widely acknowledged victory.

The proper mix of aircraft and missiles for our defensive and offensive strength is determined after careful assessment. It should be changed as required to meet shifting tactical and strategic needs. To do it in a deliberately created atmosphere of hysteria in reaction to the Russian display will ill serve the nation.

Diversion of our attention at this time from missiles and space vehicles to manned aircraft could be a deliberate tactic on the part of the wily Mr. Khrushchev. Let's not jump blindly at the bait.

We realize we are leaving ourselves open to a charge of special pleading, since our basic interest lies in the field of missiles and space.

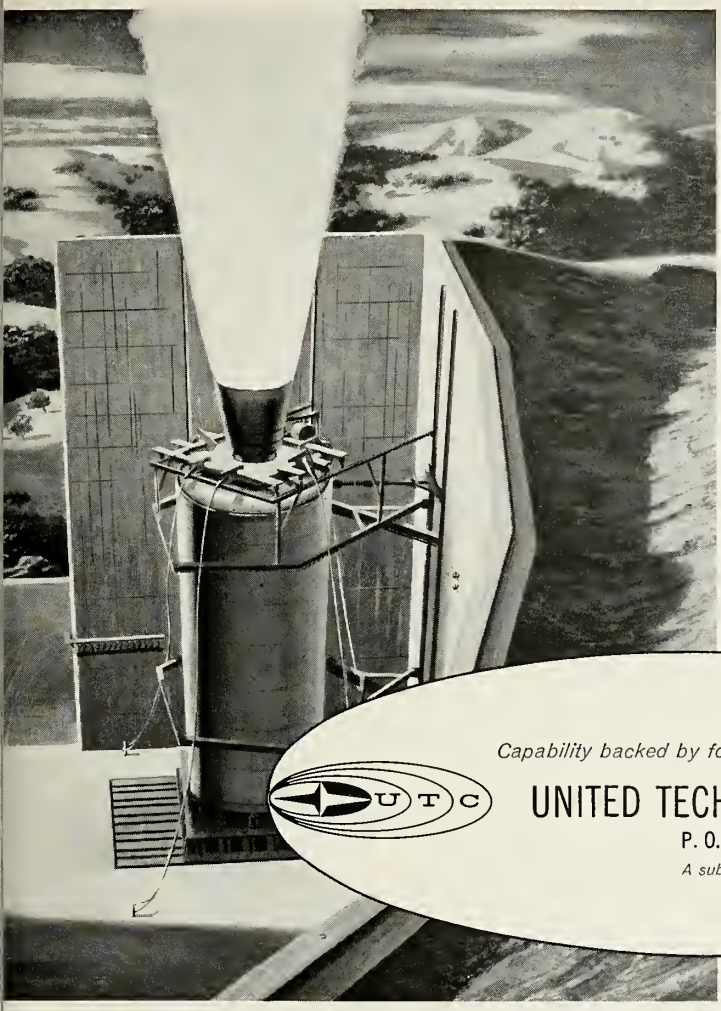
We would like, therefore, to point out that a buildup of manned aircraft would be directly to the financial advantage of firms in the missile/space industry which also are involved in aircraft production. Since we carry advertising from those firms, it presumably might be to our benefit to keep our thoughts to ourselves.

We, as a magazine, cannot stomach that type of thinking. It should be no more palatable to the industry as a whole or to the nation. If the Tushino show has demonstrated an unexpected need for more manned bombers—and we have yet to see a reasoned argument proving this—then they should be purchased.

But, as *Time* magazine points out: "The best answer to Russia's new planes may not be a better plane, but a new rocket or more *Polaris* submarines."

Let's decide calmly and then act, not react.

William J. Coughlin



Left: Test-firing of large, flight-weight solid propellant rockets at UTC Development Center is important phase of multi-million pound thrust booster development program.

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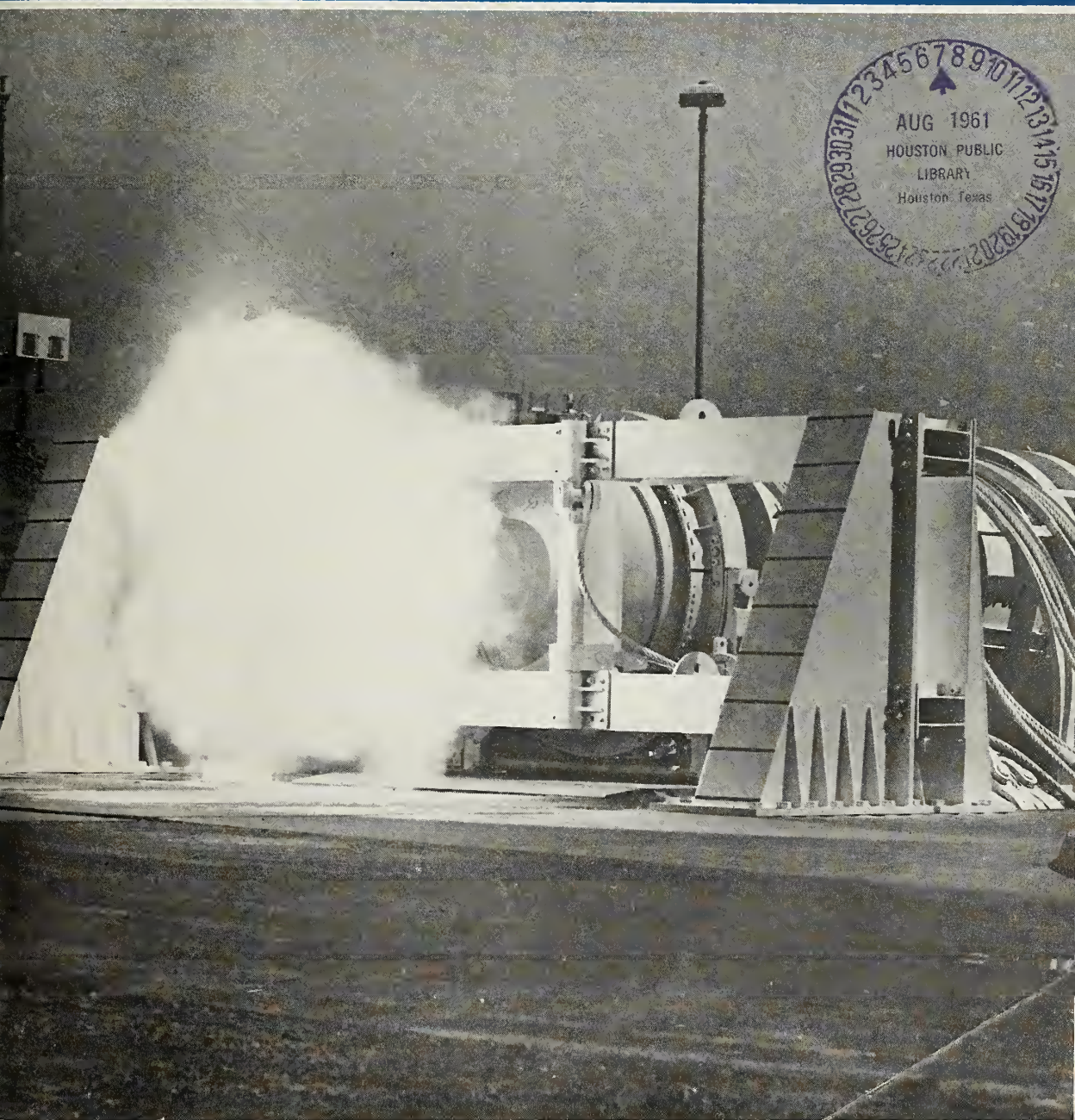


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AUGUST [illegible], 1961

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THE MISSILE/SPACE WEEKLY



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Moment of ignition—Aerojet's big solid motor

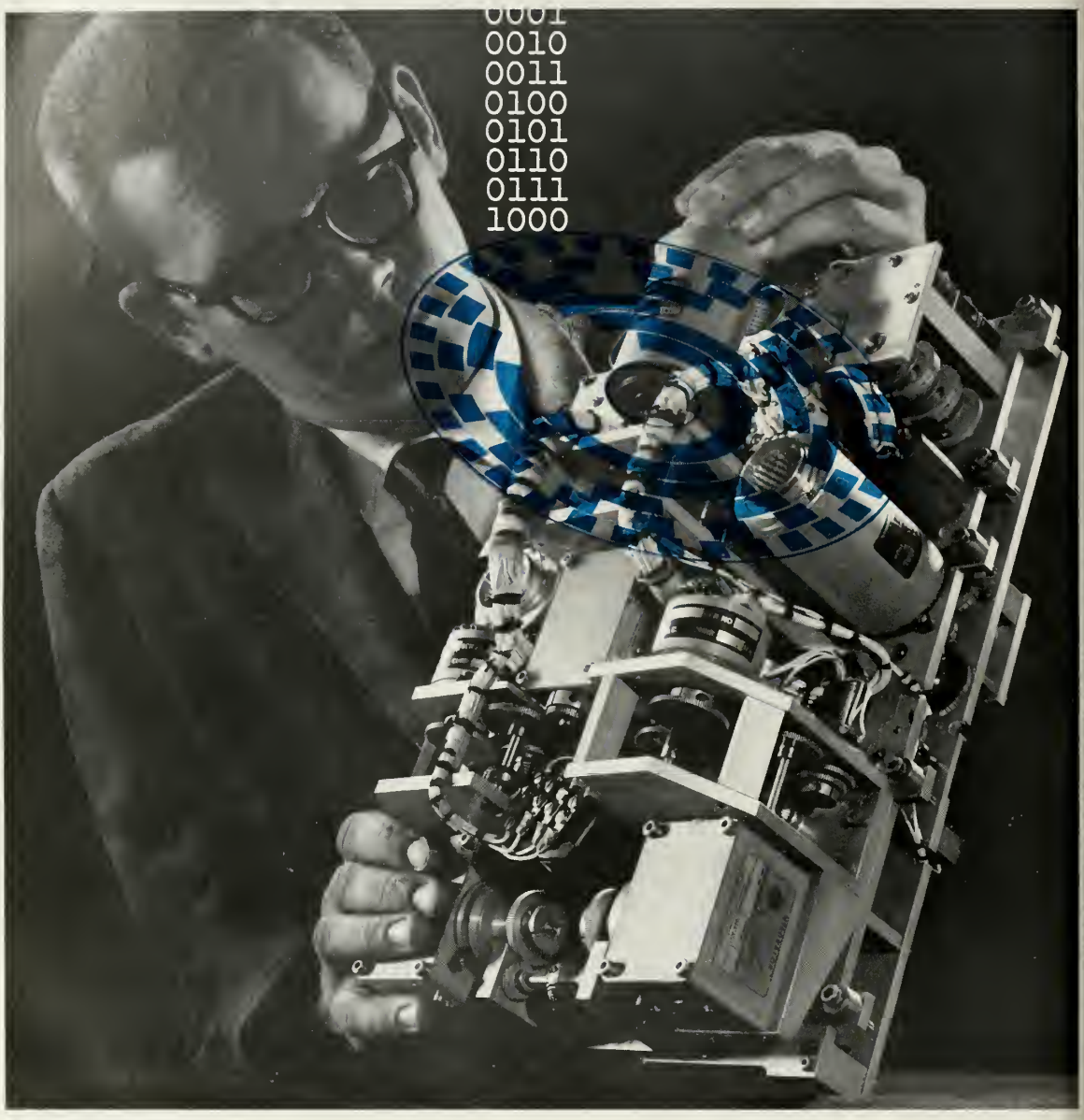
Permanent $47 Billion DOD Budget He

Major Saturn Program Changes on We

Blimps for Mercury Ocean Recovery? .

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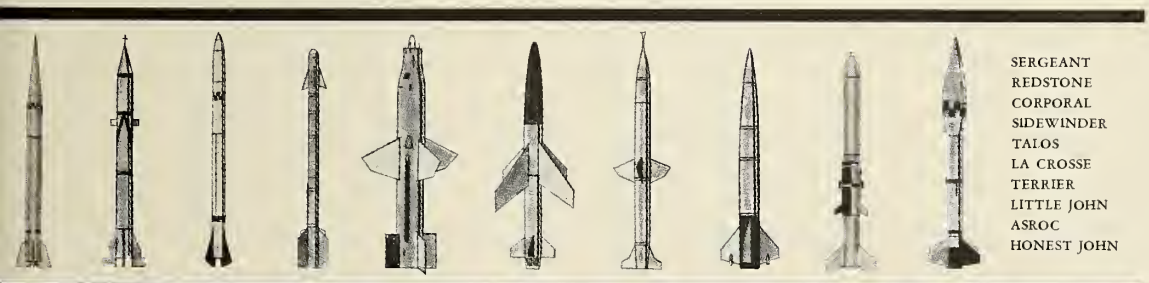
GENERAL PRECISION

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The "Pay Point" of a missile





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LITTLE JOHN
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HONEST JOHN

From conception through production to detonation, a warhead's successful mission is assured by Honeywell capabilities.

It is obvious that a missile is useless unless its warhead performs properly. The most important consideration is when and where the warhead detonates. Provision must also be made to insure against premature detonation. Honeywell experience has solved these problems for many types of nuclear and non-nuclear warheads. Honeywell warhead systems or subsystems are on all of the missiles shown above.

The Department of Defense conceives a missile to accomplish a specific task. In many instances, Honeywell assists in developing the weapon concept. User requirements are analyzed as the first step in synthesizing a new warhead system. Lethality evaluations are performed on proposed nuclear and non-nuclear kill mechanisms. System criteria are optimized, including economic considerations. A feasibility study is then performed; following approval of the concept by the government, design and development begins. Honeywell technical and management skills can be applied to any or all phases of a warhead system development, from concept to production.

System management of warhead programs is only part of our story. Honeywell has developed and manufactured many types of safing, arming and fuzing components for the three military services and the Atomic Energy Commission. Company and government sponsored programs are now in progress to develop advanced components for future missile and space requirements.

Honeywell's wide experience and management capabilities can assist on your warhead project—from conception to detonation. For more information contact your local representative, or write: HONEYWELL, ORDNANCE DIVISION, HOPKINS, MINNESOTA. *Sales and Service Offices in all principal cities of the free world.*

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MARTIN NUCLEAR ROCKET PROGRAM

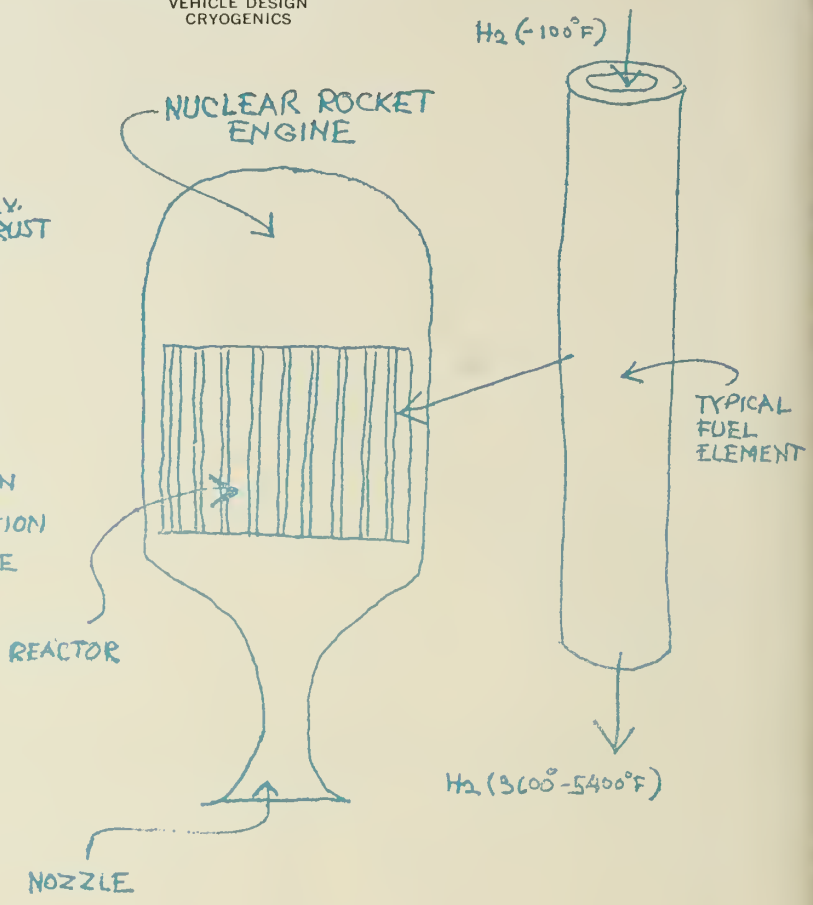
REACTOR DESIGN
PROPULSION REACTOR START-UP
NUCLEAR ROCKET SAFETY ANALYSIS
RADIATION EFFECTS ON ROCKET SYSTEM
FUEL ELEMENT DEVELOPMENT
VEHICLE DESIGN
CRYOGENICS

DESIGN OBJECTIVES:

HIGH TEMPERATURE
HIGH FLOW RATE
} MAX. THRUST

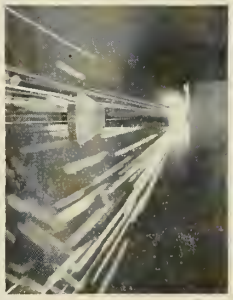
STRUCTURAL STRENGTH AT HIGH TEMP.
- G. LOADS
- PRESSURE DROP
- THERMAL STRESS

NO HYDROGEN CORROSION
LOW NEUTRON ABSORPTION
MIN. RADIATION DAMAGE



THE PROBLEM OF FUEL ELEMENT DEVELOPMENT FOR NUCLEAR ROCKETS

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Test of a fuel element in a plazma jet chamber being conducted at Martin's Nuclear Division.

MARTIN

THE MISSILE / SPACE WEEKLY

missiles and rockets

Volume 9, Number 6 August 7, 1961

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THE COVER

Powerful solid motor springs to life during a recent test firing at Aerojet-General. The 30-ft.-long motor weighs 55 tons, contains nearly 50 tons of propellant. (Aerojet Photo)

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letters

Mach's "Dean Drive"

To the Editor:

It seems really surprising that after 300 years of a successfully grown science of mechanics, the proposed Dean System Drive can cause such an amount of discussion and even confusion.

Beside other remarkable achievements, classical Galilean-Newtonian mechanics is able to provide the necessary physical concepts and mathematical tools to pre-determine the orbits and trajectories of satellites and moon or Venus probes, and mechanical technology, based on these concepts is able to put ballistic objects into these orbits, and this with quite a good accuracy.

Therefore, it should be obvious that some of these classical concepts, for example, the laws of motion—conservation of momentum, action and reaction—and Corollary IV—related to the conservation of the common center of gravity of a system—of Newton's Principia (1686) will be sufficient not only to understand the behavior of the Dean System Drive, but also to evaluate it realistically.

A short investigation of earlier literature related to mechanics confirmed this assumption and, moreover, provided some additional interesting information concerning the drive system in question.

For example, valuable and pertinent information was found in the well-known and quite fundamental book of E. Mach: Die Mechanik in ihrer Entwicklung, historisch-kritisch dargestellt, and especially in Chapter III of this work, bearing the title: "Later applications of the principles of and further developments of mechanics." A word-for-word translation of the German title of the above book is: The development of mechanics, historically and critically presented.

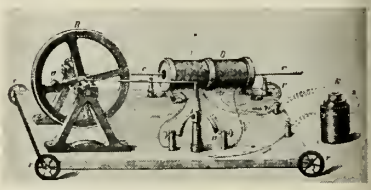
The first German edition of Mach's book was published in 1883. English, French, Italian and Russian translations followed, showing the international appreciation of this work. An American edition with the title: The Science of Mechanics, was published 1902 in Chicago. Very recently, a low-cost reprint of this was made available.

For this letter, the 8th edition, published 1921 and identical with the 7th edition of 1912 was used.

The following text represents a condensation of Section 3 with the title: The laws of the conservation of momentum, of the conservation of the common center of gravity of a system and the law of equal areas. This Section 3 is a sub-division of the before mentioned Chapter III. The below referenced Fig. 150 is given on page 299 of the 8th German edition, 1921. Two photostats of this Fig. 150 are submitted with this letter (see photo).

In this Section 3, Mach considers a steam railroad locomotive, either freely suspended or resting with very low friction on, for example, greased rails. As soon as the heavy masses linked with the reciprocating pistons are set into oscillations, the body of the locomotive is also set into oscillations of opposite sense; this occurs in accordance with the law of the conservation of the center of gravity of the entire system. To avoid such disturbing oscillations of the locomotive's body, it is only necessary to compensate or counterbalance the oscillations of the masses linked with the pistons by arranging adequate counter-weights or masses on the drive wheels of the locomotive.

Mach then adds that this behavior as described by the law of the conservation of the center of gravity of a system can



easily be demonstrated with the reciprocating electromotor of Page, mounted on a carriage provided with the wheels r-r. If the iron core or piston c in the coils A-B is pulled by the electromagnetic forces of the coils to the right or left, the assembly of the electromotor and carriage is forced to the left and right respectively. By arranging a displaceable "inertial" mass (a) on one of the spokes of the flywheel R in such a manner that its motion occurs in opposite direction of the motion of the core (c), the step-like motions or oscillations of the motor carriage assembly can either be decreased or entirely suppressed.

Undeniably, the model shown by Fig. 150 exhibits a striking similarity with the Dean system drive; of course, the Dean arrangement embodies some more sophisticated and refined details. However, in both models the physical "working principle" is basically the same.

The first (1883) edition of Mach's book was not available, however, it can safely be assumed that the prototype "drive system" of Fig. 150 was already shown in the 1883 edition. In his foreword to this 1883 edition, Mach also mentions that all the different demonstration models and apparatus discussed in this edition were laid out by him and built under his supervision in the physics laboratory of the University of Prague.

W. J. Lohninger
Dept. of the Army
Ordnance Corps
Picatinny Arsenal
Dover, N. J.

Non-profit "Truth"

To the Editor:

In reference to your editorial of July 3, *(Thoughts on Non-Profit Firms)* I am

wondering if I can convert you to the way of the meet, the right, and the truth.

I do not know why you should support or defend the so-called non-profit corporations set up by the Air Force, namely STL, SDC and ASC, also MITRE, etc. You certainly are not representing your public by so doing.

You are sacrificing your moral scruples by supporting these organizations and you are doing it simply for the advertising accounts which they have with you. In this regard, I should mention that it is not generally known why these organizations were set up in the first place, and if the reason you gave in your editorial is true—that of providing increased salaries for the privileged few—then your public certainly would not condone this action by the government.

The point is that these corporations are irresponsible. They spend large amounts of money on advertising and publicity which is unjustified. They call it a salary survey, under the guise of recruiting. *This is a fraud.* There is no telling how much the ballot box of job openings has been stuffed, in the minds of your public and the general public, by these so-called "salary surveys." It is fraudulent to pull a fire alarm box, that is, I mean it is against the law. It is also fraudulent to cry wolf when there is no wolf, and it is also fraudulent to offer something for sale (in this case jobs) when there is no job. If you doubt the facts I can tell you that the ones who are doing these activities do not deny what they are doing—they do not deny that they are participating in a gigantic hoax when they carry on this advertising and promotion of which we speak.

I therefore give you the opportunity to clean yourself up by declaring a moratorium in order to look into the facts or to enter a demurrer, in which case you will some day find yourself up against the U.S. Attorney General's office if I have my way.

From your writing I know you to be sensitive to the needs and tempo of our times. By taking a more democratic stand you will be a positive influence upon your country to the extent that you get read or heard through your magazine.

Gene C. Burns
Jackson, Mich.

Redhead Propulsion

To the Editor:

In reference to M/R July 24, page 32, your article on the successful firing of the Redhead/Roadrunner.

It was an excellent article but it does not give credit where credit is due. Without the Marquardt propulsion system, this vehicle would never have made this successful flight. Nowhere in your article do you mention The Marquardt Corporation.

William E. Warner
Advanced Design Dept.
The Marquardt Corporation
Van Nuys, Calif.

(Full marks to Marquardt whose contribution we certainly did not intend to slight—Ed.)

Increased technical responsibilities in the field of range measurements have required the creation of new positions at the Lincoln Laboratory. We invite inquiries from senior members of the scientific community interested in participating with us in solving problems of the greatest urgency in the defense of the Nation.

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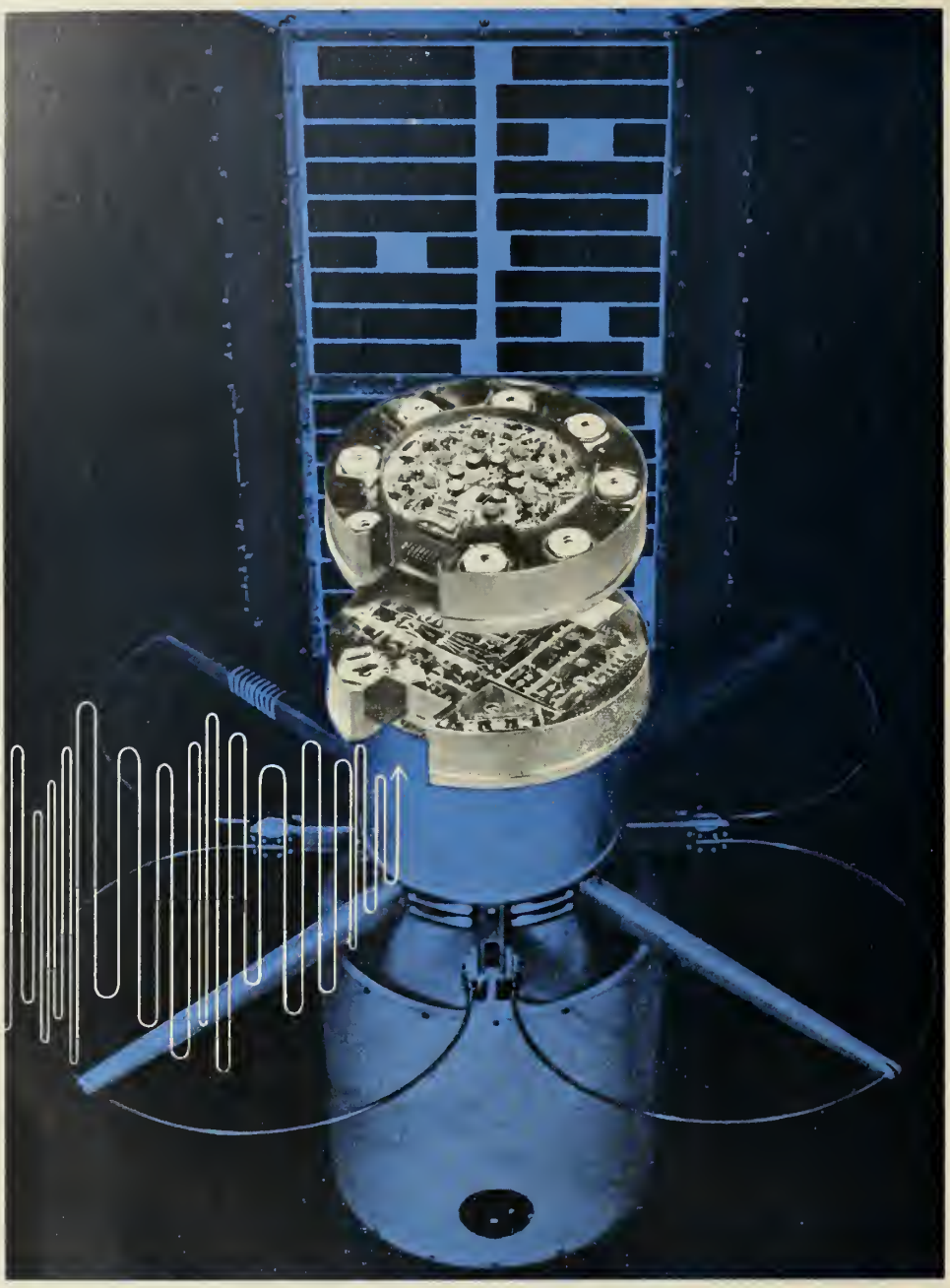
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The Countdown

WASHINGTON

The Shape of ICBM's To Come

Air Force plans for the configuration of a third generation ICBM are stymied hy the continued U.S. temporizing over resumption of nuclear testing. A firm decision on testing resumption one way or the other would vitally affect the specifications for a small ICBM such as the so-called *Midgetman* concept. And a number of military planners says the time for making a decision on a third generation ICBM is already overdue.

Dyna-Soar: More Bird Sooner

The Air Force is expected to use the House-added $85 million for *Dyna-Soar* to try to begin the first suh-orbital flights as much as six months sooner. The money also is expected to he used to tackle some tough phases of the program earlier and therehy purchase extra time to lick any unanticipated problems. Before the increase, the Air Force had planned to launch the first sub-orhital *Dyna-Soars* in 1963-1964.

From ARPA to Sea to PMR

The former deputy commander of ARPA in its greater days—Rear Adm. John E. Clark—is assuming command of the vast Pacific Missile Range. He succeeds Rear Adm. Jack Monroe. Clark has heen serving in the Atlantic as commander of Carrier Division 16.

Red Army Strength Challenged

The Defense Department now feels that the Red Army has heen overrated. It outclasses the U.S. Army in mechanization and firepower; it also has twice as many men. But, on the Central Front in Europe, the NATO forces are helieved to out-man the Russians even without planned increases. (Disclaimer: Those advancing this argument do not deny there are still a lot of soldiers and tanks where the Red Army in Central Europe came from.)

Other Programs Dept.

Officials at NASA are planning to stress the peacetime uses of space and programs other than *Apollo* in their speeches. The reason: Officials fear the puhlic will get the idea that the *Apollo* man-to-the-moon is the agency's sole project.

New Zeus Test Phase Underway

The next-to-final phase in the testing of the Western Electric *Nike-Zeus* anti-ICBM is taking place at Pt. Mugu, Calif. All three of the big missile's stages will he ignited for the first time in flight. Previously, in tests at White Sands, only the first two stages could he ignited because of range limitations.

NASA Rejects Pershing as Booster

Officials at NASA are understood to have rejected a proposal hy the Martin Co. to use *Pershing* as a space hooster for space prohes and small satellites. *Pershing* would be suhstituted for *Scout* in a numher of NASA projects—hut agency officials said they saw no overall gain in doing it.

INDUSTRY

Sweetening the Space Net

International communications carriers have a new wrinkle to make their proposed non-profit corporation for operating a commercial communication satellite system more palatahle to the government. They plan to allow all international carriers use of the system and engage in any form of traffic desired. The promoters of the plan argue that this would ensure no discrimination among carriers.

More Work Shifts for Industry

The Pentagon policy in expanding procurement orders will he to advocate maximum use of extra shifts and minimum huilding of new production facilities. DOD expects almost all of the $1.7 hillion in new hardware procurement added to the FY '62 budget to be produced within the next year on present assemhly lines.

PERT Joins NASA

NASA has adopted the *Polaris* program's famed PERT system to keep track of all of the agency's projects and contracts—including the hig *Apollo* man-to-the-moon program. The PERT system used at NASA is somewhat simplified in that only one time estimate for completion dates is heing used rather than several as called for hy other agencies employing the system.

INTERNATIONAL

And Now Vostok II?

Rumors of an impending new Soviet space shot are being spread in at least three of the world's capitals. The launching is said to he another Soviet man-in-space shot. The manned spacecraft is expected to orbit the earth at least two or three times before landing.

Booming Business at Woomera

Testing at the British-Australian Woomera Weapons Research Range is expanding so rapidly that a major housing program is needed for technicians and workers. The program is scheduled to cost $4.2 million.

The Polariski Subs Were Missing

Western ohservers especially ohserved that the Russians did not produce any missile-launching nuclear-powered submarines at the recent Red Navy show at Leningrad. The Soviets have boasted that they now have more of them than the United States. The failure of at least one of the suhs to make an appearance increased the belief of U.S. officials that the hest the Soviets have so far is a nuclear-powered suh capahle of launching only short range missiles.

Ranger Shot Postponed

A rash of technical malfunctions forced several postponements in the scheduled launch of the *Ranger I* lunar spacecraft.

First slated to go on July 26, the technical difficulties raised the possibility that the shot might have to be put off until late this month or early in September.

Lunar shots can only be attempted during the so-called window period when the sun, moon and earth are in the proper positions.

This window period lasts about 8 days a month and has already been exceeded because of the various postponements.

The most serious difficulty which arose was a spurious signal in the spacecraft which killed the Aug. 2 shot.

Two other official postponements were necessitated by a power failure at Cape Canaveral and a ground support problem when a LOX valve stuck, causing a helium leak in the spacecraft.

Besides testing the reliability of the spacecraft, the *Ranger* shot is intended to check out new equipment including an attitude stabilization system based on celestial reference, a high-gain pointable antenna, an advance communication system, the development of components able to operate for long periods and calibration of solar cells in a space environment.

Douglas Realigns for Space Push



ABLE

A major realignment of the Douglas Aircraft Company — designed to strengthen its missile and space potential— was announced this week.

Heading the two newly formed divisions—one for missiles and space and the other for military and commercial aircraft—are Charles R. Able and Jackson R. McGowen, respectively. They have been named Vice-Presidents and General Managers of their respective divisions and will report directly to the President, Donald W. Douglas, Jr.

The new missiles and space division will be responsible for development and production of the *Thor, Skybolt* and *Genie* for the Air Force, the *Nike-Zeus* for the Army and the *Saturn S-IV* stage for NASA.

In announcing the changes, Company president Douglas said that "the creation of these two integrated product divisions recognizes the vast growth in the missiles and space field and strengthens us for the future development of aircraft."

RIFT Contracts Awarded

NASA has awarded four firms six month contracts to study design problems involved in flight testing a nuclear rocket engine in an upper stage on a *Saturn* booster.

The firms include Martin Co.'s Denver Div., Lockheed Aircraft Co., General Dynamics Astronautics, and Douglas Aircraft Corp.

Each will receive about $75,000 in government funds. Each will work independently with the studies scheduled for completion by the end of this year.

Last year, both Martin and Lockheed received $100,000 study contracts under the Reactor In Flight (RIFT) program.

While test flight of a nuclear rocket is the primary concern, the new contracts anticipate that data furnished by the RIFT flight test program will have a direct application to operational space exploration vehicles.

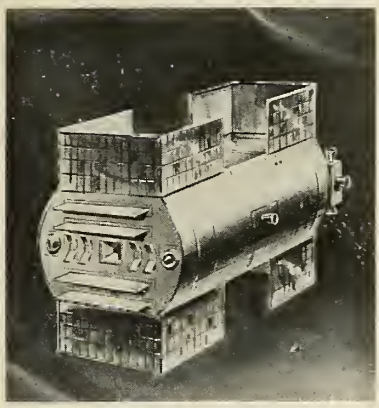
Shots of the Week

Vital information on the heating and temperature rates of nuclear power devices during re-entry were collected by the 5000 mile flight of an *Atlas* missile down the Atlantic Range this week.

The Atlas nose cone was designed to eject a pyrotechniques display at 100,000-400,000 feet which could be photographed from Ascension Island to determine what would happen in

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Lockheed ComSat

AN ARTIST'S CONCEPT of a 24-hour, synchronous satellite which could be launched within 18 months was revealed this week by J. Douglas Sailor, a scientist at Lockheed's Missiles & Space Company at the fourth western meeting of the American Astronautical Society. The attitude-controlled, solar-powered satellite would be lofted into orbit by the Atlas/Agena B and a small solid third stage rocket. Sailor predicted an operational vehicle could be available well within four years.

the burn-up of a radio-active generator.

Later tests—using more than 30 separate capsules and different materials—will be used to determine the minimum size and weight of safety devices for nuclear missiles and spacecraft.

The pyrotechniques display in this week's shot consisted of burning sodium and potassium and not actual radioactive materials.

On July 27, a *Minuteman* was successfully fired on a 5000 mile trip but telemetry was lost on the way. This was the third shot for the year with a success in February and a failure in May.

A *Polaris A-2* soared from a pad at Canaveral and went down the Atlantic Missile Range in a successful shot Aug. 2. No range was announced, but presumably the shot went 1400 miles plus.

Goldberg Lauds Base Progress

Secretary of Labor Arthur Goldberg returned to Washington after a two-day trip to four missile bases with members of the President's Missile Sites Labor Commission and promptly praised workers and contractors for the work "being performed with great expedition and great dedication."

Earlier in the week at Cape Canaveral, the first stop on his tour, Goldberg had revealed a letter that the President had written him expressing concern over missile base delays.

"The nation cannot afford the luxury," the President's letter said, "of avoidable delay in our missile and space program." And it indicated strongly that these delays would not be tolerated.

However, on his return to Washington, Goldberg noted that the days lost due to strikes in July had dropped to an all-time low of 209 days—.0002 percent of the more than a million man-days worked.

He noted that problems still exist such as travel pay for workers commuting long distances each day, inadequate housing and jurisdictional problems arising from the complexity of the missile programs. These, he hopes, can be solved by the cooperation of both the unions and the contractors with the Missile Sites Labor Commission.

The Labor Secretary's 6700 mile inspection tour took him to Cape Canaveral, Strategic Air Command Hq's at Omaha, Vandenberg AFB and Mountain Home AFB in Idaho.

Anderson Takes Over as CNO

Admiral George W. Anderson became the new Chief of Naval Operations this week, replacing retiring Adm. Arleigh A. Burke.

One of Anderson's first actions was to dispatch a message to naval units throughout the world assuring them that he would keep the Navy "on course and steaming strong."

Anderson in the past has been rated as a close associate of the now fading "New Look" of the Eisenhower administration.



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New DOD Budget Level Fixed at $47 Billion—or Higher

Latest Kennedy strategy aimed at opening up use of limited war forces for Cold War political jockeying; military commanders get 'options' with NATO division buildup

by James Baar

THE NEWLY-revised Kennedy defense budget is designed to prepare the way for the nation's limited war forces to go on the offensive in the political Cold War.

This fact became clear this week as the $47 billion military budget moved swiftly through Congress and Soviet Premier Nikita Khrushchev continued to make threatening noises and gestures over Berlin.

Three other important aspects of the new budget that also became clear were:

—The United States is seeking to expand the number of NATO divisions on the Central European front from 20 to 30. More U.S. troops will be contributed; the European NATO allies are expected to do likewise.

—The United States has no plan to rely solely on non-nuclear forces should war break out with the Soviet Union.

—The new budget level of $47 billion probably will become a Cold War fixture for the foreseeable future. And if the Berlin situation worsens the figure would go up.

Congress completed passage Aug. 3 on the increased military authorization bill for missiles, planes and ships and sent it to the White House. The $13.5 billion bill included the extra $1 billion President Kennedy requested only a week before.

Meantime, Congress neared final action on the expanded $46.8 billion military appropriations bill. As it cleared the Senate Appropriations Committee, this bill included not only all of the extra $3.5 billion sought by Kennedy in his new requests but also $525 million for big bomber procurement and $228 million more B-70 R&D unsought by Kennedy.

• **Option Power**—Acting Chairman A. Willis Roberston of the Defense Appropriations Subcommittee said the "committee felt we could not put our entire dependence on long-range missiles." Other congressmen previously have insisted that the extra bombers also will be needed as carriers for the 1000-mile range *Skybolt*.

However, the Administration continues to stand firm in its determination not to spend the additional bomber money.

The new plan for the nation's Armed Forces that is now unfolding is based on what the Pentagon top civilian command refers to as the doctrines of "conventional option" and "controlled response."

What this means essentially is the final junking of the old doctrine of "massive retaliation" espoused by the Eisenhower Administration in favor of forces that permit a greater variety of military action. But it does not mean that the Kennedy Administration is preparing to refight World War II.

The forces that Pentagon plans now call for will enable field commanders to have a considerably wider option in taking military action. Also these forces will enable NATO and the United States to combat—and possibly engage in—the kind of military jockeying of power that has enabled the Soviet Union to wage political aggression throughout the world.

Among other things, the increase in limited war forces will enable the United States to mount a realistic airlift to Berlin if desired. The increase also opens the way for a far greater mobilization in short order if one is needed.

• **Familiar refrain**—The Pentagon's new plans are said to be a result of the extensive studies which have been conducted over the last six months. However, they also significantly parallel much of the thinking of the President's new personal military adviser, Gen. Maxwell Taylor (ret.).

Taylor, who as Army Chief of Staff bitterly opposed the doctrine of massive retaliation, has called his substitute for it the "National Military Program of Flexible Response." The "conventional option" and "controlled response" have much in common with the "flexible response."

Whatever name they go by, the new plans will mean considerably more military spending than under the Eisenhower Administration. If only the new force levels are made permanent giving the Army two or three more divisions, the defense budget is expected to remain at $47 billion.

The possibility of reduction in any key area is slim. Some of the big missile programs—*Titan* and *Atlas*—are nearly purchased. But *Minuteman* and *Polaris* even without possible new increases are expected to cost billions more; military space programs are expected to cost increasingly large sums; and the deployment of the *Nike-Zeus*—a Taylor favorite—would cost $8 billion alone.

Moreover, some of the costs of increasing the nation's limited war forces such as keeping the Fleet from slowly falling apart have yet to be touched.

A budget of $47 billion probably is conservative. One expert of increasing stature in the capital these days put the price tag at $50 to $55 billion nearly two years ago and warned there was little time left to act. The expert's name is Maxwell Taylor ⁂

part of speedup . . .

NASA Dropping Saturn C-2 Booster

Up to 20 C-1 vehicles will be built—15 by industry; more changes are coming in race for the moon

by Hal Taylor

A 50-TON minimum weight specification for the *Apollo* lunar spacecraft is prompting NASA to discard plans for the "middleweight" *Saturn C-2* booster. The agency now intends to jump directly from the *Saturn C-1* to the *Saturn C-3*.

The switch is intended to expedite development of the *C-3* booster which also may be upgraded from 3 million lbs. thrust to 4.5 million lbs. by the addition of a third F-1 engine.

NASA officials believe the change will make it possible to have the *C-3* operational by late 1965 or early 1966. This time scale could put the United States in a more competitive position with Russia for a 1967 landing of an expedition on the moon.

The three-stage *C-2* was designed to either earth orbit 45,000 lb. or boost 15,000 lbs. to escape velocity. This would have been sufficient only for earth orbiting a 12,500 lb. *Apollo* command module and a space laboratory which apparently now has been sidelined for the main assault on the moon. New plans also call for a heavier command module, perhaps 20,000 lbs. or more.

Reshuffling of *Saturn* now indicates that NASA might be able to follow this optimum *Apollo* flight plan:

—Manned earth orbital flights of the three-man capsule about 1964-65 using *Saturn C-1*.

—Lunar orbit of the command capsule plus a propulsion module in late 1966 or early 1967 using *Saturn C-3*.

—Rendezvous experiments with *Saturn C-3* in high orbits in the 1965-67 period.

—Attempt at a lunar landing launched from orbit or a direct flight from earth using a *Nova* superbooster. possibly in late 1967 or early 1968.

• **Weight not set**—Projection of flight schedules much beyond *Saturn C-1*, however, is still very nebulous since the weight of the *Apollo* spacecraft still is not frozen, nor the multitude of design problems overcome.

NASA officials estimate that once the *Apollo* achieves escape velocity it will need a propulsion capability 12 times its own weight to effect a lunar landing and takeoff.

If the *Apollo* lunar vehicle weighs somewhere between 50 and 75 tons (see below), a rendezvous refueling technique is seen necessary using an uprated *Saturn C-3* as the primary booster. The parallel development of 9-12 million lb. thrust liquid or solid *Nova* vehicles, to be launched under the FY '62 budget by NASA and the Air Force, could avoid this complicated step—if *Nova*

(Continued on page 45)

Competition Starts for Building 50-75 Ton Apollo Spacecraft

NASA OPENED the competition about a month early last week on the multi-million-dollar contract to build the *Apollo* lunar spacecraft.

At the same time, it was disclosed that new specifications call for a lunar spacecraft weighing from 50 to 75 tons total. The command module alone may scale from 10 to 20 tons.

Bids are due by Oct. 9 with a prime contract award expected about January.

Firms asked to submit proposals include Boeing, Chance-Vought, General Dynamics, Douglas, General Electric, Goodyear, Grumman, Lockheed, Martin, McDonnell, North American and Republic Aviation.

The spacecraft—designed to carry three men to the moon and back—will not have wings, but it will be a lifting vehicle.

Some aerodynamic lift is needed so that it can maneuver through the atmosphere on re-entry.

As a result, the L/D ratio will be somewhere between .5 and 1. The lift surfaces are necessary to permit the spacecraft to hit a recovery area on return to earth that has been established



Martin Co. Apollo concept

at about 3000 miles long and 500 miles wide.

With the spacecraft's weight at escape velocity estimated at 100,000 to 150,000 lbs., NASA officials said roughly one third of this will return to the earth.

The Command Module will be 13 to 15 ft. wide and about 12 ft. long. Total length of the spacecraft including escape tower, booster facilities, and air lock is estimated at 55 to 60 ft. long. Final dimensions will be determined by the winning contractor.

Recovery will probably be by parachute, but the Space Agency is conducting, along with several private firms, studies of the flexible wing recovery technique.

There are no present plans to include atomic powered batteries in the spacecraft. Instead, the contractors have been ordered to investigate and consider solar cells, fuel cells and motor generator sets.

Apollo will also have the same basic systems as the Project *Mercury* spacecrafts including an environmental control system, a communications system and guidance and control. All of these will be much more sophisticated than that carried on the Freedom 7 or Liberty Bell 7 capsules.

Specifications for the spacecraft were prepared by NASA following feasibility studies by Martin, Convair, GE, and the Space Agency itself.

Contract for *Apollo* will be awarded late this year or early in 1962. ⁂

with modifications . . .

Dyna-Soar 'Picks-off' X-15 Hardware

Space Bomber will adopt some concepts, inertial platform to be most direct "steal"

by Bill Wilks



NEW BALL NOSE of X-15 may go aboard Dyna-Soar

EDWARDS AFB, CALIF.—*Dyna-Soar* will pick off major subsystems and concepts developed in the *X-15* program, including the ball nose, inertial platform, ballistic controls, stability augmentation and side-arm controller.

The National Aeronautics and Space Administration Flight Research Center here, reports the *X-15* also is being used as a test bed for concepts applicable to a variety of vehicles including the B-70, *Aerospace Plane, Apollo,* supersonic transport and low-level attack aircraft.

"But *Dyna-Soar* hardware will look more like the *X-15*'s than will that of the others," says Jim Love, NASA *X-15* project manager. *Dyna-Soar* also will benefit from features of the *X-15*'s landing gear, structure and materials, pilot and ground handling techniques, pilot's environmental system, auxiliary power units and pilot's biomedical monitoring program.

"When I say, 'pick off,' I don't mean a particular item will be used 'as is,' " adds Love. "Modifications are necessary, and the state of the art keeps improving. The ball nose is an example of this."

• **Unique nose**—Pocked by five holes of about ¼-in. diameter to obtain air flow information, the ball rotates on the *X-15* but probably would be fixed on *Dyna-Soar*. There still is some question as to whether the ball nose developed by Nortronics division of Northrop Corp., will go into *Dyna-Soar* since there might be a problem of the orifices fusing over with ceramic material during re-entry heating. Studies are underway to determine the best materials to meet this problem.

In *Dyna-Soar* the ball would be fixed to avoid the complexity involved in the hydraulic and servomechanisms required to rotate it. It probably would be ceramic-coated. The *X-15*'s is uncoated.

With a fixed ball, some type of onboard computer will be necessary to calculate the pressure differentials across the holes, figure out the angle of attack and convert it to a pilot display.

Dyna-Soar re-entry will not be as critical as that for the *X-15*. It will be able to absorb heat at a higher rate because of its material and construction.

In the North American Aviation rocket vehicle, the nose ball takes over

(Continued on page 44)

in ComSat case . . .

NASA Stakes Out New Licensing Policy

Space Agency claims new plan is necessary to prevent satellite communications monopoly in launch contract with AT&T

NASA has established an "open door" license policy in cooperative ventures with private industry.

In a contract signed last week to launch up to four American Telephone & Telegraph-owned experimental communications satellites, the space agency staked claim to royalty-free license rights on all new technological developments achieved by AT&T in building the satellite system. NASA also retains the power to assign these same rights to any other commercial firm it chooses.

Officials indicate, moreover, that the same provision may be written into future contracts where NASA performs certain services for private enterprise.

The explanation for the new policy given by NASA is that it needs these rights to prevent any one firm from monopolizing the space communications business.

Signing of the contract was announced as NASA released more details of its Project *Relay* communications satellite, which will be built under a $3 million contract with Radio Corporation of America. In other ComSat developments:

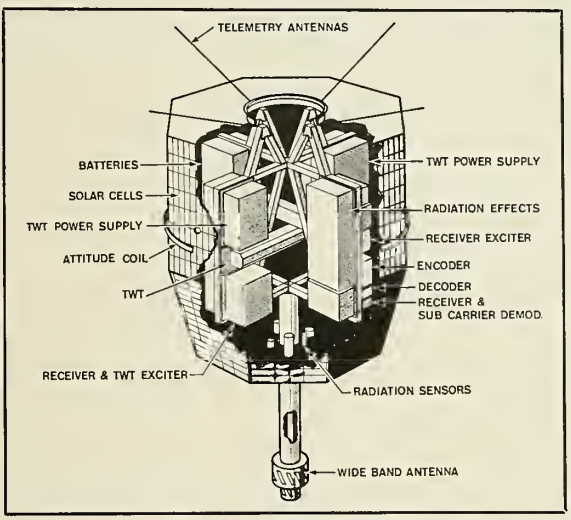
—The House Small Business Anti-Monopoly Subcommittee ordered the Federal Communications Commission to appear this week on the commission's plans for a privately owned ComSat system.

—The eight-member international communication common carrier *ad hoc* committee held its first organizational meeting. The committee has been ordered to prepare plans for a privately owned system by Oct. 13. The companies reportedly are leaning toward a non-profit corporation which would lease circuits to any communications carrier desiring to use them.

NASA officials contend that neither Project *Relay* nor the contract with AT&T represent a government attempt to control the communications satellite system. They said that both steps are necessary to advance research and development leading to a worldwide system.

Although very similar, Project *Relay* and the AT&T satellites differ in one important respect.

• **Contract details**—The AT&T satellites will receive signals from ground stations at a frequency of 6390 mc, about three times the frequency of 1725 mc used by *Relay*.



CUTAWAY of NASA Relay satellite

AT&T feels that the ultimate operational system will perform better and have greater capabilities at the higher frequencies.

Under the contract NASA will launch two AT&T satellites in April and October 1962. The firm can also exercise an option to launch two backup satellites in June and December. It is estimated that each firing using the *Thor Delta* booster will cost the space agency $6 million.

AT&T will design and build the satellites at its own expense and will reimburse NASA for the costs of the services and facilities which it provides including launching and range tracking.

The AT&T satellites will be spherically shaped and will weigh 125 lbs. each. They will be launched into elliptical orbits approximately 600 miles from the earth at perigee and 3000 miles at apogee. Inclination to the earth will be 45 degrees. Their power supply will be nickel-cadmium storage batteries.

Wideband communications experiments—television, two way telephone, radio and telegraphy—will be transmitted between the AT&T ground stations located at Rumford, Me. and Holmdel, N.J., via the satellites.

• **Relay details**—The eight-sided *Relay* satellite, weighing approximately 100 lbs. will be launched by a *Delta* rocket from the Atlantic Missile Range in 1962. The orbit will be elliptical, with a perigee of nearly 900 miles and an apogee of 3000 miles. The equatorial inclination will be approximately 48 degrees.

Somewhat barrel shaped, the satellite will be 26 in. in diameter and 29 in. high, excluding antennas. Power for the spacecraft equipment will be furnished by some 6000 radiation protected solar cells mounted on the sides.

For greater reliability, the satellite will contain two communications transponders, each capable of receiving and transmitting either television, two way telephone, or other forms of wide-band data. Ground command stations will select the transponder and its mode of operation for any given transmission.

The transponders will receive the transmitted information from the ground on a planned frequency of 1725 mc. After the transponder amplifies the signal, it will be retransmitted to the ground at a frequency of 4170 mc by a special 10-watt traveling wave tube.

Other instrumentation in the satellite includes two command control receivers and decoders which will be used to operate the electronic equipment via a radio control link from the NASA Minitrack network and a pulse code telemetry system to transmit performance data on the satellite's equipment and radiation experiments. ⁂


US NAVY

Mercury Rescue: Mission for Blimps?

new technique proposed to save astronaut and capsule

but Navy is cool to LTA buffs seeking new space role for airships

by William E. Howard

LIGHTER-THAN-AIR buffs in industry are trying to pump new life into the all-but-extinct blimp. They believe available Navy airships are the best means of rescuing *Mercury* astronauts from the sea.

Several arguments are being advanced to the Navy:

—A blimp has the lifting capacity to pull even a water-filled *Mercury* capsule from the ocean.

—ASW blimps now in the process of being discarded by the Navy could replace the carrier and some of the surface vessels now being tied up by the *Mercury* program and release them for combat duty in the Berlin crisis.

—Use of an airship would remove any problem caused by downwash from a helicopter hovering over an astronaut floundering in the water.

—Sea rescue by blimps were effected repeatedly in World War II.

These points were raised this week following the loss of the Liberty Bell 7 capsule, which sank in 2800 fathoms of water at the end of the *Mercury-Redstone* flight July 21. Loss of the capsule, which filled with water when an escape hatch blew out prematurely, was attributed to a faulty engine indicator light in the helicopter trying to recover it. The pilot cast off the weighted capsule when he thought his engines were overheating.

Astronaut Virgil Grissom, who was hauled to safety by a second 'copter, later said he was bothered by the downwash of the helicopters circling overhead. He had difficulty struggling to reach a rescue harness as his spacesuit rapidly filled with water.

There has been consideration of employing larger helicopters—but this only magnifies the downwash problem. The Navy, which is in charge of the recovery operation, in any event has limited the helicopter size to those which can be deployed from an LSD (landing ship dock) deck in case a carrier is not available.

• **Navy cool**—Although some industry sources claim the Navy once ran a study showing blimps could perform the *Mercury* rescue-recovery mission, the Navy now says it does not consider them feasible. The reasons:



DETAIL of hoist from sea to blimp.

—Blimps lack the necessary maneuverability and hoverability for hooking on to a capsule within a safe time limit.

—Time needed to get a blimp ready to fly is too long when considered along with the start-stop problem inherent in a launch attempt.

A plan being pushed by industry, however, would overcome the first objection by lowering a fibre glass and foamed aluminum boat containing two frogmen to the capsule (see artist's conception opposite page) thus eliminating the need for hook-on hoverability. They would rig an inflatable rubber ring below the hatch line of the 9.5 ft. capsule to keep it afloat while the astronaut disembarks.

The same rigging would be used to lift the capsule to the airship, or hold it for recovery by surface ships.

The astronaut would be hoisted to the airship gondola which could be outfitted with medical equipment and doctors to give him emergency treatment or post-flight examinations. (The boat itself would be part of the floor of the gondola.)

On the second point, the airship proponents maintain that the unrefueled endurance of an airship is two days (against a few hours for a helicopter.) They contend, moreover, that the 45-knot speed of a blimp—about half that of a helicopter—would be ample if two, or more blimps were assigned to patrol the recovery area for an orbital *Mercury* flight.

NASA expects a *Mercury* capsule returning from three orbits to impact somewhere in a strip of ocean about 600 miles long off Puerto Rico. High speed aircraft and helicopters presently are planned for unmanned orbital shot due in the next two months.

• **LTA controversy**—Another advantage cited for the blimp is that two or three positioned over the predicted impact area could carry the electronic gear to track the reentering capsule.

But the prospect of these and other arguments making any headway appear dim. The last of the ASW blimp fleet is being dismantled at Lakehurst, N.J. All but two ships, which will be retained for ASW research, are being decommissioned.

The personnel at Lakehurst are being disbanded. The whole operation will wind up in October. Unless moves are undertaken speedily, there is little chance that the blimp fleet can be kept intact.

Many in the Navy are saying farewell with relief. The Atlantic fleet never has shown great enthusiasm for blimps, despite their record of usefulness in World War II. Today, many officials are inclined to look at sausage-shaped airships as little more than outmoded—and expensive toys.

LTA buffs feel the critics are unfair. They have advanced plans to carry *Saturn* boosters from their manufacturing plants to their launch pads and suggested many other chores for the blimp in the Space Age.

They claim the blimp has a lot of life left. They just want a chance to prove it with *Mercury*. ⌘



A cross-section of the 40 subsystems incorporating 3500 electronic parts which go into TIROS III are framed by two satellites. All components must be thoroughly tested, precisely integrated and must function perfectly if the satellite is to perform successfully.

NASA's Hurricane spotting TIROS III maintains projects' fine performance record

With the successful launching of TIROS III, meteorologists for the first time will see the total cloud formations and measure the radiative energy balance of hurricanes which plague the eastern coast of North and Central America each year. For TIROS III was launched at this time for precisely this purpose. From information gained from TIROS III, meteorologists may learn much more about the birth and life cycle of tropical storms.

TIROS III DESIGN

Although the spacecraft configuration is essentially the same as the previous two highly reliable TIROS satellites, TIROS III has two wide-angle cameras and the National Aeronautics and Space Administration has placed new omnidirectional IR sensors aboard to measure thermal radiation from the earth and sun.

THIRD OF A FAMOUS FAMILY

TIROS III is the third of a highly successful series of experimental weather satellites which were developed, along with the associated ground equipment, for the NASA, under contract with the Goddard Space Flight Center, by RCA's Space Center. All of them have established "firsts" in the United States' space program.

TIROS II established a longevity record for a complex satellite. Still operating after nearly eight months and over 3300 orbits, TIROS II has transmitted over 34,000 photographs to the ground. Aside from its impressive meteorological achievement, historians may well point to this long-term performance as the first to prove that a satellite system could operate reliably for so many months in a space environment thus proving the feasibility of operational satellites.

TIROS I was the first satellite, carrying advanced television equipment, which sent photographs of the earth's cloud cover to meteorologists. From TIROS I's 23,000 photographs, meteorologists found that satellites could be used for weather observation and analysis. The pictorial information is particularly useful in the two-thirds of the world from which few or no weather observations are now available.

CONNOTATIONS FOR THE FUTURE

The TIROS series has proved beyond a doubt that the peaceful uses of space will benefit all mankind. Six nations participated in the utilization of information from TIROS II and more will take advantage of TIROS III. RCA is also already at work on the camera systems and space power supply for NIMBUS, the next generation of meteorological satellites.

If you are a professional physicist, engineer, or mathematician and interested in participating in such challenging projects and stimulating team efforts, contact the Employment Manager, RCA Astro-Electronics Division, Defense Electronic Products, Princeton, N. J. All qualified applicants are considered regardless of race, creed, color or national origin.

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Technical Countdown

ASTRONAUTICS

Able-Star Breakup Still a Mystery

The unexplained operation of the destruct system initiating detonation of the unused hypergolic propellants in the tanks is thought to have caused the break-up of the *Able-Star* upper stage which launched *Transit IV-A* on June 29. A battery in the destruct system was kept alive for the first time in a test of battery life expectancy and, for this reason, there was no automatic short-out of the destruct system. Another conjecture—admittedly unlikely—is that an impacting meteoroid caused the tanks to detonate.

Loss of Muscle Tone a Problem for Astronauts

Bioscientists—studying the problem's of man's adaptability to space—have concluded that one of the major problems for future astronauts will be the loss of muscle tone from living without gravity. Extrapolating from the body's reaction to long periods of inaction—such as long confinement in a hospital or floating in water the scientists found that under such conditions man's tolerance to stress, temperature, acceleration or tilting was reduced.

AEC Radiation Dosages Inapplicable to Space

A study—conducted by the Martin Co. as part of the *Apollo* program—indicates that man in space may be required to endure short term radiation dosages much in excess of recommended AEC levels. Based on an accumulation over a 45-year working life, the AEC levels call for an average of 5 rem per year plus an emergency dosage of 25 rem. More applicable, says the Martin study, would be the figures and effects used by civil defense planners. These describe emergency doses of radiation of 100-200 rem.

PROPULSION

Spark Plugs Make Space-Age Comeback

Aerojet-General, Sacramento has returned to an early method of starting rocket engines. Spark plugs have been used for over 20 starts (with the same set of plugs) with many starts of over 20 secs. duration. One liquid rocket was fired seven times in a short period without changing the plugs in order to demonstrate a restart capability for space vehicles.

Able-Star II Work Started

Initial work is underway on *Able-Star II* at Space-General. This newest restartable configuration—scheduled for future space missions—will be able to orbit a larger payload than *Able-Star I*. It uses a higher thrust engine and an all-new ablative thrust chamber. The LOX-Hydrogen *Star II* will provide an upper stage for either the *Titan* or *Atlas*.

X-15 to Have Greater Throttling Capability

The *X-15*'s large engine is being modified to enable throttling from 30 to 100 percent thrust, thereby increasing its flight profile for test purposes. The XLR-99 engine is presently capable of 50-100 percent throttling—from 30,000-60,000 lbs. thrust. With the modification, thrust can be varied down to 16,000 lbs., thus filling the gap created when the *X-15* switched from the two 16,000 lbs. thrust engines. First flight with the modified engine is scheduled for September.

SUPPORT EQUIPMENT

Fast Loading System Developed for Silos

A loading system—capable of "dropping" *Atlas* ICBMs into a silo in 13 mins.—has been developed by General Dynamics/Astronautics. The "mobile silo missile erector" is trailer-mounted with a self-contained power supply. It can erect an *Atlas* for lowering into a silo in up to 60 mph winds.

F-100 Used to Study Spacecraft Landings

The Air Force has modified an F-100F Super Sabre in a program similar to that conducted with an F-104 at Edwards AFB for development of spacecraft landing techniques. Simulating the landing of a boost-glide vehicle, the F-100 lands at 230 mph without power and approaches at a very steep angle. The program may determine the length of runways required for landing of *Dyna-Soar* type vehicles.

Precise Timing Device Installed at PMR

A centralized system to automatically record the exact timing in missile launch operations is being installed at PMR headquarters. The electronic system marks film and tape records of launches with the exact day, hour, minute, second and tenth of a second through use of a timing generator sending out 100 electronic pulses of varying widths every second. The pulses are put on the film or tape records of a launch and, by comparing the pattern of the pulses against a master tape, it is possible to determine the exact time of a particular event.

MATERIALS

Cryogenic Nuclear Studies Launched

Neutron absorption scattering cross section of hydrogen at cryogenic temperatures will be investigated by Astra, Inc. in cooperation with North Carolina State College under a NASA contract. First phases will be theoretical with experimental designs following. Studies will have direct application to nuclear rockets.

Solar Energy Converter Studies Extended

Development of a solar energy converter will be extended another year at National Research Corp. under a $79,800 Air Force contract. The lightweight unit is based on the theory and designs of Professor T. Gold, Cornell University, NRC consultant.

Cosmic Ray Experiments Scheduled

The Navy plans to launch 12 large balloons from Fort Churchill to measure the charge distribution and the energy spectrum of the heavy nuclear components in primary cosmic rays. The flights are part of the Navy's Project Skyhook. NASA will foot the bill for 11 shots and the Office of Naval Research picks up the tab on one.

Compact Engine Boosts Navy Target Drone

Liquid rocket being produced by Rocketdyne weighs only 17 lbs., produces 685-lb.-thrust for Beech's XKD-2B-1—a Mach 2 target which soars to 70,000 ft. in 22 seconds

by Frank G. McGuire



SEVENTEEN pound P-4 engine uses storable fuel, and is only 18.5 in. tall. P4-1 is slightly larger.

CANOGA PARK, CALIF.—A compact, mass-produced liquid rocket engine has been developed by Rocketdyne to boost the Navy's latest target missile to 70,000 ft. in 55 seconds at Mach 2.

The missile, Beech Aircraft's *XKD-2B-1* uses the 685-lb.-thrust dual-chamber engine, weighing only 17 lbs., in any one of 32 mission profiles to give supersonic high-altitude jet interceptors a run for their money. The engine is now undergoing flight tests and preliminary flight rating tests. The first of its two configurations is expected to be operational in a little over a year.

Using storable fuels, Hydyne and IRFNA, the engine is designed with extreme simplicity, uses explosively formed parts, and has a ceramic liner which reduces heat problems and permits operation over wide thrust ranges. Ignition is hypergolic.

The basic unit is designated P-4, the longer version P4-1. Both produce the same amount of thrust. The P4-1 has a dial system for thrust selection, and dry-start propellant lines. Both engines produce maximum thrust for five minutes, and minimum thrust for eight and one-half minutes.

Beech's 560-lb.-gross-weight *XKD-2B-1* target was developed under a joint Navy/USAF contract, and will become operational with the Navy for both aircraft and shipboard-missile training.

• **Performance** — The Rocketdyne engine powers the vehicle from 500 to 70,000 ft. at speeds from Mach 1.2 to Mach 2. Longest endurance is at Mach 1.5 and 70,000 ft., when the target is fully powered for eight minutes. At 5000 ft. and Mach 1.2, the vehicle is good for 75 seconds. Performance for both versions of the engine is practically identical.

The basic P-4 engine is 18.5 in. long; the P4-1 is 21 in. long. Both weigh 5 lbs. and are 9 in. high. The dry weights are 16.7 for the P-4 and 22.0 lbs. for the P4-1.

Thrust levels for the booster chamber are from 220 to 685 lbs. at a specific impulse of 231 sec., nominally at 35,000 ft. Sustainer thrust level at 262 sec. specific impulse and 70,000 ft. is from 85 to 130 lbs.

Gaseous nitrogen is used for pressurization in both configurations of the engine, and start/stop capability is available at any altitude from zero to 100,000 ft.

• **Controls** — Thrust control and mixture-ratio control is governed by a thrust selection dial system on the P4-1, while the P-4 uses fixed orifices. Sustainer thrust chamber pressure is nominally 303 psia and booster chamber pressure is nominally 200 psia.

Thrust level on the P4-1 is controlled by an orifice selector valve which provides four thrust combinations for

each chamber, with one of the sustainer thrust combinations being blank to provide zero thrust in case the mission requires no sustainer operation.

Sixteen thrust combinations are possible with each of two tank pressure settings, and a field adjustment can increase this to 32 combinations if desired.

The valve has two orifice cylinders for propellants, one metering sustainer flow and the other booster flow. Each has a lower series of orifices to control oxidizer flow and another, upper series to control fuel flow. Selection of propellant flow is made by choosing combinations of these orifices; since both sets of orifices are on the same cylinder, it is impossible to get the wrong mixture ratio.

Intermixing of propellant within this valve is prevented by a series of three O-ring seals on the cylinder between the upper and lower half. In addition, vent holes are located in the valve body between each of the three O-rings to allow escape of any leaking fluid before it gets to its hypergolic mate.

Booster cutoff is accomplished in this same valve by a single pressure cartridge which shuts off both fuel and oxidizer flow to the booster thrust chamber. This cartridge pushes the detent release plunger forward, releasing the spring-loaded poppets which stop propellant flow.

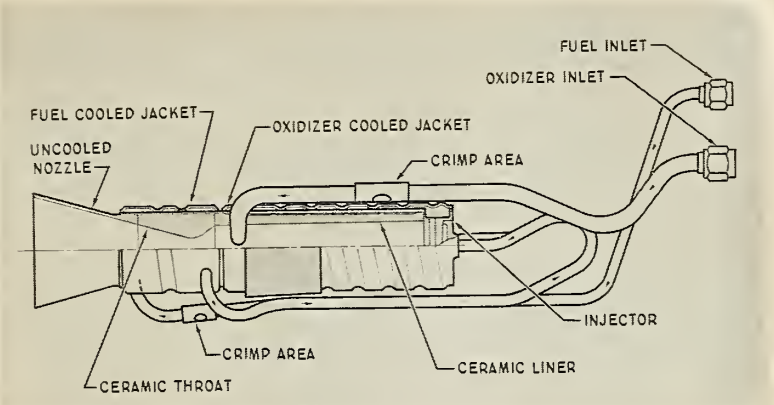
• **Fabrication**—Part of the economy in P-4 and P4-1 is in the fabrication of components. Explosive forming is used to produce the stainless-steel thrust chambers, making a highly reproducible and high-volume item with consistent quality control.

Another aspect is the reduction of components, as evidenced by the calibration technique used. To get the required Delta-P, a technician places a tool on the lines and gradually crimps a section until a flowmeter reads the desired level. The unit is then permanently calibrated. If over-crimping occurs, pressure is put into the line to remove the crimp.

The regeneratively-cooled chambers use a stainless-steel wall construction, a Hastelloy uncooled extension, a refrasil liner and a ceramic throat in the exhaust cone. The outer wall of the thrust chamber is explosively formed, then the liner is placed inside. The outer wall is designed to provide a spiralling coolant passage for the oxidizer.

The uncooled nozzle extension permits changing of altitude optimums for best performance. The oxidizer flows from the aft end of the chamber wall and enters the injector after cooling the chamber. Fuel enters the forward end of the unit and flows directly into the injector.

The aforementioned crimping area



Sustainer Chamber

makes the chambers interchangeable with respect to pressure drop across the coolant jacket and the injector.

In the sustainer chamber, a ceramic liner is used instead of the refrasil, and both fuel and oxidizer are used for cooling. The ceramic liner provides a lower heat flux than the resin-type used on the booster.

The nozzle extension used with the sustainer has a greater expansion ratio —24 to 1—than the booster, which has a 6.4-to-1 design; thus the sustainer performs better at high altitudes.

The throat section of the sustainer is cooled with fuel, while the combustion chamber uses oxidizer. A double-weld joint between the two coolant jackets prevents fluids from leaking from one section to the other.

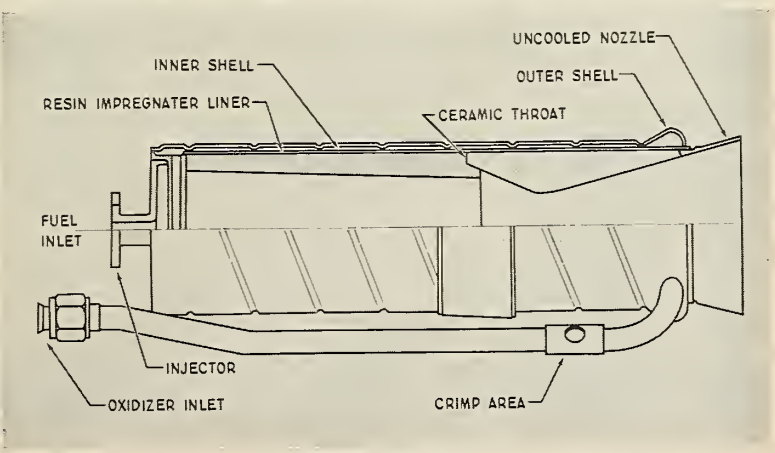
There is no shutoff provision on the sustainer, since the unit is designed to operate until fuel and oxidizer are exhausted. However, for some missions, the booster can be operated alone on all available propellant by selecting a blank setting on the orifice selector valve to prevent propellant from reaching the sustainer.

At present, the fueled engines have a two-year storage time rating, but the goal is five years. Propellants are sealed in the tanks, out of contact with any sealing materials. When the engines are to be used, a squib shears off the tank caps to permit passage of fluid into the previously dry lines.

At the electrical start signal, a pressure-cartridge-actuated burst disc in the pressurizing valve admits gaseous nitrogen to the propellant tanks through check valves and burst diaphragms. Then the two normally-closed propellant valves are similarly actuated, allowing fluids to flow to both chambers where they ignite hypergolically for the boost phase. The booster chamber is cut off at a pre-determined point.

In the start sequence, a slight delay is built into the system to allow cooling oxidizer to flow into the chamber passages before fuel enters the injector. In this fashion, both fluids enter the injector simultaneously, even though the oxidizer has a longer flow path to follow.

Development of the engine began in July, 1959, for the P-4 and in October, 1960, for the P4-1. First deliveries of both types have already been made. ⁂



Booster Chamber

Explosive Forming Procedure Near

High energy rate process in development since Jan. '60. Ryan forming massive rocket fuel chamber bulkheads

EXPLOSIVE FORMING techniques being developed at Martin Co., Baltimore, are expected to reach production capabilities within a year.

Research engineers have been working on the process since January, 1960. The method frees fabricators from the size restrictions of existing presses.

Scale model torus tanks are currently being formed explosively, considerably reducing the weldage and piece work involved in conventional fabrication.

Normal torus tank construction means welding 40 separate pieces to form the finished product. Scale explosive forming experiments use 12 pieces and cut welding footage by 40%. The tank was made in two sections. Five pieces were welded into a cake-pan preform.

The preform was placed in a die, filled with water including a suspended explosive charge. A large holding ring, clamped over the outer edge, assured the necessary seal for drawing a vacuum in the die. In this case the charge was circular in shape.

After detonation, the preform resembles a hollow doughnut sliced sidewise.

• **Exotic fabrication** — Explosive forming is actually the earliest known method of high energy rate metal forming. It was first used by an Englishman, W. Claude Johnson, in 1897. Since 1957, a very large segment of the missile/space industry has moved into the field.



CAKE-PAN PREFORM for scale torus tank is welded from twelve sections for explosive forming rather than the forty sections in conventional fabrication.

Production Stage at Martin

The method is only one of many forms of high and medium energy rate processes being developed in the U.S. but it spawned most of the others. The largest obstacle is that the explosives are involved and almost every municipality has well defined and prohibitive laws governing the use of such materials. While these were originally directed against firearms and then heavy construction, a limiting condition existed before industrial use of explosives for fabricating evolved to its current state.

Much remains to be learned about the process. But the swift movement of the missile/space industry into tougher and tougher materials, outstripping the capabilities of the most advanced metal working techniques is again placing prime emphasis on effect and leaving the cause, or understanding, running a poor second. In this case, the effects are practically finished products.

High energy forming is basically the same as the more familiar, conventional forming methods. Force and time are still the dominant characteristics. The real problem is in the nature of the workpiece and what happens during the process. This is the area being intensely investigated by government, industrial and academic researchers.

• **Huge parts**—In application, explosive forming is moving into the massive product area. Ryan Aeronautical Co. is currently working on a gore 15 ft. in length and 8 ft. wide at the broadest end.

The gore is one section of a huge elliptical dome which could be part of a large rocket fuel tank. The gore die is a concrete fiberglass-faced tool weighing over 40 tons. The gore itself will be fashioned from 5086 aluminum alloy, representing the biggest explosive forming job at Ryan to date.

In spite of the rapidity of high energy rate forming, the metal itself moves relatively slowly—around 100 to 200 fps, a velocity below the critical impact velocity of most metals.

The explosive is separated from the workpiece by a coupling medium such as water. This fluid has the effect of rounding off the pressure pulse generated by the detonation, which in turn prolongs the pressure-work time over the metal to be formed. Charge distance is known to be extremely critical. ⁂



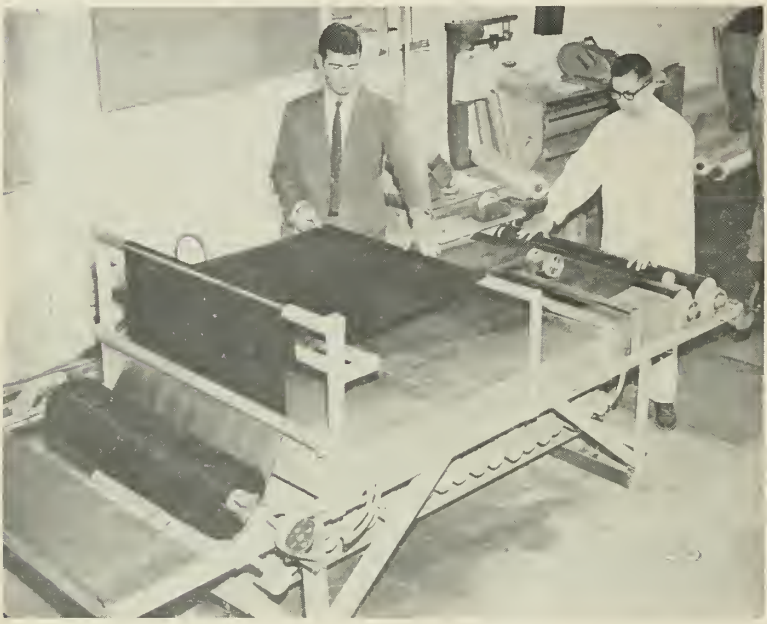
CIRCULAR SHAPED charge forces the preform against the die in the Martin tank.



FINISHED TORUS configuration illustrates the capabilities of the high energy rate forming method. Martin did not reveal ultimate use of such tanks.

Off the Loom: Rocket Ablative Material

High temperature fabric by Thompson Fiber Glass reported to possess far better thermal properties than graphite



LOS ANGELES.—Erosion-resistant ablative materials for high-temperature rocket engines have been developed by H. I. Thompson Fiber Glass Co.

The carbonaceous materials, designated HITCO-C, have a purity of 98% carbon and are being fabricated in both fiber and fabric form.

The company says the materials retain strength over a broad temperature range, and even show a strength increase at temperatures over 3000°F. Compatible with most resin systems, the HITCO-C series can be fabricated by standard reinforced plastic techniques such as high-pressure molding and tape winding.

J. Pat Sterry, Manager of the Materials Research Division for H. I. Thompson, said the materials have the high-temperature erosion-resistance characteristics of graphite materials, but their thermal conductivity is orders of magnitudes lower.

"There are other carbonaceous materials on the market," Sterry said, "but they evolve large quantities of gases and will shrink and lose over half their strength before they reach 1500°F. Some of them also lose their identity when used with resins, and therefore don't serve any reinforcing function."

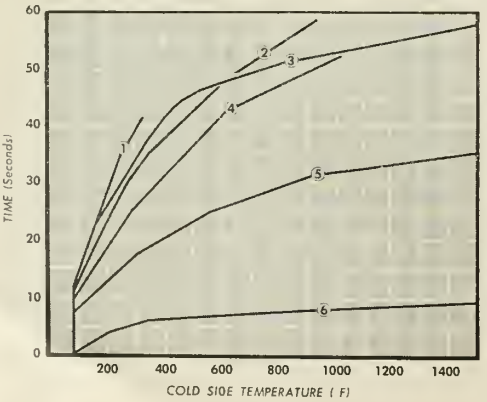
• **High properties**—He said the HITCO-C series currently consists of the fiber and cloth materials, both of which are now in production. The satin-weave cloth is being produced in rolls 32 in. wide and 50-75 yds. long. Its warp break strength is 25 lb./in. or greater, and weight per linear yard is about 7.5 oz.

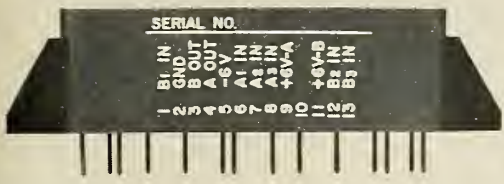
Using molded parts of 50% fiber and 50% phenolic resin (by weights), the company found that the mechanical properties of the fibers were quite high. Tensile strength is about 8500 psi, flexural strength is 15,000 psi, compressive strength about 19,000 psi and flexural modulus 1.9 x 10^6 psi. Sterry expects that the fabric laminate properties now being measured will prove to have higher values than the fiber-resin.

(Continued on page 50)

Preliminary Test Data

Cold Side Temperature vs. Time During Ablation Test





In less time than it takes light to cross this room, a new product, **DELCO'S NEW** high speed **10 MC** silicon modules, could: (1) correct the course of a missile in flight; (2) make it possible for sonar pickups to track and compute the position of targets with microsecond accuracy; and (3) handle any number of other airborne guidance and control functions that previous modules—due to low speed or environmental or performance limitations—could not handle. Delco Radio's 10mc modules, with a maximum gate-switch speed of 40 nanoseconds, convert data 100 times faster—even under the most extreme environmental conditions.

These **SILICON** modules come epoxy encapsulated, and operate over a temperature range of −55°C to +100°C. And these same reliable **DIGITAL** circuits are available packaged on plug-in circuit cards. These Delco **MODULES** are environmentally proved to: **SHOCK**, 1,000G's in all planes. **VIBRATION**, 15G's at 10 to 2,000 cps. **HUMIDITY**, 95% at max. temp. **STORAGE AND STERILIZATION TEMP.** −65°C to +125°C. **ACCELERATION**, 20G's. Designed for systems using from one module to 100,000, and the module's rated performance considers the problems of interconnection. Data sheets are available. Just write or call our Military Sales Department.

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TYPICAL MULTI-CHANNEL MEMORY UNIT ★



MARQUARDT MULTI-CHANNEL MEMORY SYSTEM

allows realistic simulation of longer range and lower altitude tactical training missions

Based on a major technical breakthrough in information storage, Marquardt's new bombardier/navigator radar trainer system provides outstanding simulation characteristics. The flexibility and capacity of the Multi-Channel Memory—a high density storage medium—make possible realistic simulation systems capable of meeting the advancing speed, range, and altitude requirements of aero-space technology.

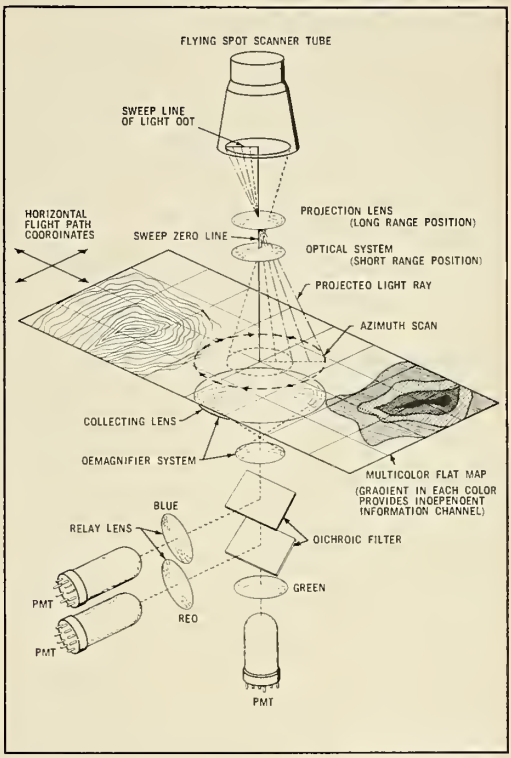
The Multi-Channel Memory uses a three color film transparency in which terrain information and radar reflectivity data are stored on a map scale ratio of three million to one, or better. A highly detailed terrain map representing a land mass area 2,000 miles by 3,000 miles can be permanently stored on a slide only 48 inches by 72 inches. Because the map transparency is flat and terrain elevations are reproduced electro-optically, there are no physical limitations to its use. The system is particularly well suited for very low altitude simulation.

Information in the Multi-Channel Memory System is coded as varying densities of the three colors of the film transparency. During operation the transparent map is scanned by a flying spot scanner. After passing through the film the light is separated into various channels by filters and mirrors and converted to electronic signals by photomultiplier tubes. The light intensity in each channel is dependent upon the absorption of the corresponding color dye in the film. The signals are then processed by a high speed computer and displayed on the face of the PPI (plan-position-indicator) radar display.

Because of its flexibility and large storage capacity, the Multi-Channel Memory System has application to missile and space training problems, information storage and retrieval, automatic language translation, advanced command and control systems, and similar computer uses.

The bombardier/navigator training system mentioned above, and now being developed for the Air Force, is the result of more than ten years of experience in the development and manufacture of trainers and simulators. Marquardt has successfully produced, installed and maintained world-wide—on time and at low cost—bombing and navigation trainers, gunnery radar trainers, AEW/CIC trainers, special purpose trainers, and ground control intercept trainers. For information concerning Marquardt's training and simulation systems capabilities, contact William Lord, Pomona Division, The Marquardt Corporation, Pomona, California.

Scientists and engineers experienced in the fields of simulation and training systems are invited to investigate exceptional career opportunities with The Marquardt Corporation. All qualified applicants will receive consideration regardless of race, creed, color, or national origin.



DATA EXTRACTION FROM COLOR TRANSPARENCY
The principle of land mass simulation storage and readout is shown above. Terrain elevation and radar reflectivity are coded as varying densities of the three colors of a color film transparency. As the light source simulates airborne radar scan, signals are generated by the photomultipliers to provide information necessary to simulate a radar presentation.

★ MULTI-CHANNEL MEMORY UNIT
Shown on the opposite page is the heart of the Multi-Channel Memory System — a three color film transparency. Each color provides a permanent and separate information channel in perfect register at any point no matter how large the map.



THE Marquardt CORPORATION

CORPORATE OFFICES, VAN NUYS, CALIFORNIA

ASTRO ◆ OGDEN DIVISION
◆ POMONA DIVISION
◆ POWER SYSTEMS DIVISION

Solar Ray Storm Prediction Improved

by William Beller

A SCIENTIST at the University of California has devised a way to predict with reasonable accuracy the onset of solar cosmic-ray emissions.

He also has a fairly reliable method for making long-range estimates of the maximum number of sunspots that will occur at the peak of the next sunspot cycle.

Such information is vital for the safety of prospective space travelers, and is also of high engineering value to space-capsule designers.

The man who derived the methods is Dr. Kinsey A. Anderson, U. of C. assistant professor of physics.

• **No tarrying in space**—The danger of solar beams to astronauts was first recognized when a flare on May 12, 1959, sent protons of extremely high intensity throughout the solar system. Then—as though to drive the warning home—three very intense solar beams occurred two months later.

On the basis of the Anderson methods, it appears that four-day trips are the longest that can be made with fair assurance that no solar cosmic rays will be met. For longer trips, particularly at times of high sun-spot number, shielding is definitely needed.

Solar cosmic-ray particles, which are almost entirely protons, are the only sources of large and dangerous radiations coming from the sun. During the great July, 1959, solar proton event, the total radiation dosage might have reached 200 rem, even with radiation shielding of 8 gm/cm^2. The permissible once-in-lifetime dosage for workers in a radiation environment is regarded by many authorities as 25 rem.

Solar x-rays and electrons, including those in storm-producing gas clouds, are said to be too low in energy to have substantial penetrating power. And even solar gamma rays, though quite penetrating, occur only in very short bursts and infrequently.

• **Radio engineers used it first**—The development of a sunspot or a group of sunspots from mere specks to the maximum number of spots may take about a week. Several more weeks may pass before the last spot decays completely away. Anderson claims that the large flares that produce proton flux occur mainly in sunspot groups having lifetimes of at least one week, and particularly in those that reach a fair degree of complexity.

Anderson divides the "solar beam" prediction problem into deriving (1) a relatively long-range prediction of what the solar activity will be during the next sunspot maximum (in 1968); and (2) the day-by-day probability of avoiding a solar beam.

For predicting the peak sunspot number about three years ahead of the solar maximum, he suggests a technique radio engineers use to forecast radio propagation conditions. This is based on the data in Figure 1, where the early development of the last four sunspot cycles is shown.

The sunspot minimums are all started at t=O. Anderson observes that about 1½ years past minimum, the two cycles that will eventually attain high sunspot numbers lie distinctly above the curves that attain much lower numbers. Therefore, he concludes that the smoothed sunspot data available in late 1965 should indicate whether the peak of Cycle 20 will be extremely high or will fall substantially below the monthly average of 200 sunspots per day attained in early 1958.

The maximum sunspot number appears to be loosely connected with the number and severity of solar proton events. Therefore, even if the next cycle should be less active than the present one, there may not be complete assurance that the number of solar proton events will diminish.

• **Short-term forecasts**—The key to making short-term predictions of solar proton events lies in examining the penumbral areas of active sunspot groups. (The penumbra is the shaded area surrounding the dark portions in a sunspot.) The method of analysis:

1) The size of the penumbral area in the sunspot group of July, 1958, (Figure 3) is measured two days before the large flare of July 7. The area may be taken to be the sum of the areas of the two largest penumbral regions. The penumbral area then was

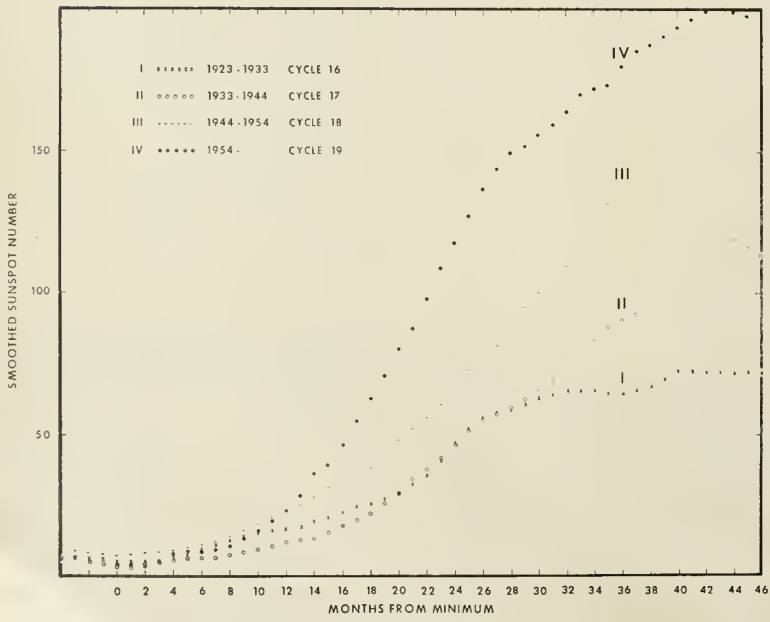


Figure 1. *At about 18 months past solar minimum the curves of smoothed sunspot numbers give a good indication of how peak sunspot numbers will be for each cycle.*

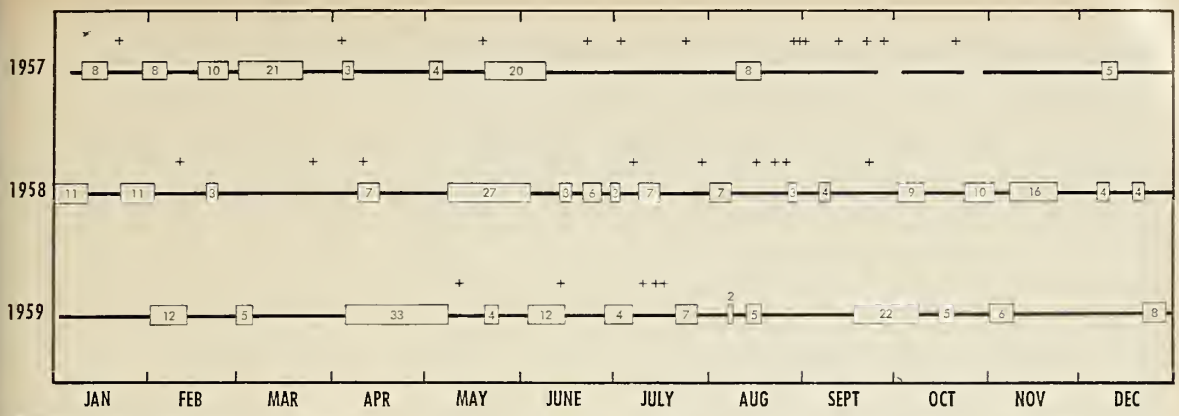


Figure 2. *The solid lines denote times when large penumbral areas were present in one or more sunspot groups. The line continues until the sunspot group goes behind the west limb even though the penumbra may have vanished before this time. The open boxes are times when only small and dissociated grey patches were present. The number in the boxes gives the time in days that this situation lasted. The crosses indicate the first arrival of solar protons at the earth.*

smaller than those in the other two sunspot groups associated with very great proton intensities at the earth during May, 1959, and July, 1959.

2) The daily sunspot records of the Athens Observatory from Jan. 1, 1957 to June 30, 1960, are next examined. Whenever the total penumbral area confined to one or two patches in a sunspot group exceeds that of the July 5, 1958 criterion size, a solid line is drawn on an axis marked off for the 365 days in a year.

The line is continued until the sunspot group leaves the visible disc, even though the penumbral areas may have completely disappeared before this time.

If, when this group disappears, the penumbral area in other sunspot groups present on the visible disc do not exceed the July 5, 1958, criterion size, an open line or box is drawn along the time axis. This is continued until a group of spots having a penumbral area greater than the criterion size appears again. The result of this analysis for the 3½-year period is shown in Figure 2.

3) The beginning of each solar proton event is then marked by a star on this plot.

A further discussion of this method is in "Preliminary Study of Prediction Aspects of Solar Cosmic Ray Events," NASA Technical Note D-700.

On the basis of Figure 2, several conclusions can be reached:

—Solar proton events occur predominantly on the solid lines.

—On two occasions, the solar proton emission began above an open line.

—In several instances, the solar proton even began very near the end of a solid line. This is described as due mostly to flares in sunspot groups just disappearing from the visible disc, in which the once large penumbra had nearly vanished.

—Since the boxes take up one-third of the total time on the diagram, it would be expected on a random-chance basis that about 13 out of the 40 solar-proton events would fall into the boxes. However, only two do.

• **Best times to travel**—Four-day excursions into space should be started when an open box appears—unless a proton event is occurring; then the trip should be delayed four days. If the box is still open when the trip is over, another should be begun at once. Even if the excursion time runs out of the box, it should be completed. (Results of such programing is shown in table.)

Through this technique, 117 round trips could have been made over a 3½-year period with only two solar-beam encounters. This is far better than random chance would have given.

When the trip is extended to seven days, chance of running out of a box and onto the line becomes more probable. Out of 77 trips, five would have met with proton flux during the 3½-year period. As the trip is extended, chance of avoiding a proton flux rapidly worsens. ⌗

Analysis of the Solar Beam Encounters of Hypothetical Space Flights Allowed by the Penumbral Development Criterion in Recent Years

Year	No. of 4-Day Round Trips Possible	No. of Solar Beam Encounters	Max. Riometer Effect for Beams Encountered	No. of 7-Day Round Trips Possible	No. of Solar Beam Encounters	Max. Riometer Effect for Beams Encountered
1957	21	0	—	16	1***	Not reported but small
1958	37	1*	3 to 4.5 db	25	1	3 to 4.5 db
1959	38	1*	1.5 db	23	2†	1.5 db >15 db (First Great July event)
1960**	21	0	—	13	1‡	Not reported, but intermediate intensity; two separate events encountered
TOTAL	117	2		77	5	
Total No. of Days Average	468			539		
Percent of Time Used, 1957-1960½	36			46		

* *These encounters unavoidable by present criterion.*
** *Up to July 1 only.*
*** *Penumbra greater than criterian size appears one day after excursian begins. Pratons arrive at earth 5 days after this.*
† *Penumbra greater than criterian size appears 2 days after excursian begins. Pratons arrive at earth 2 days after this.*
‡ *Penumbra greater than criterion size appears one day after excursion begins. Pratons arrive at earth 3 days after this.*

Moon 'Sampler' Prototype Readied

JPL studying small chromatograph built by Aerojet for inclusion in Surveyor payload; would prove absence of moon life

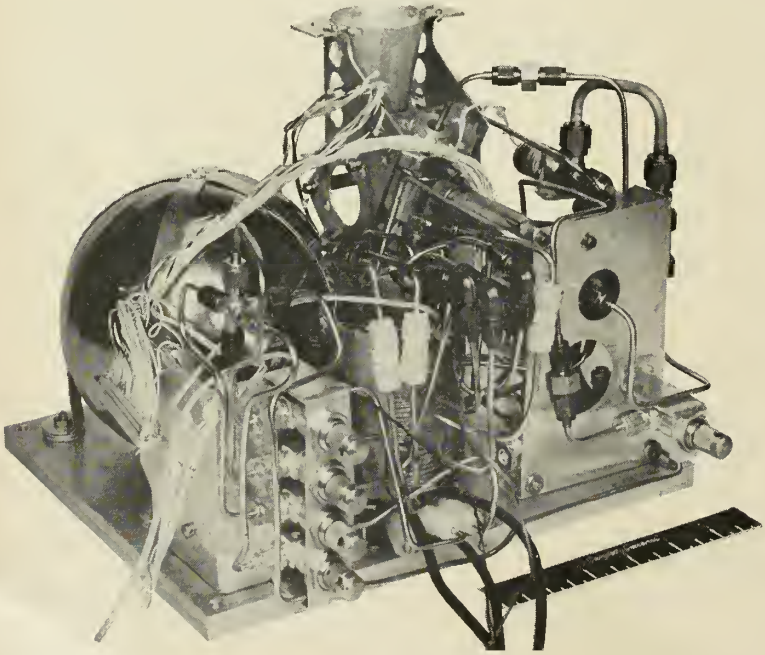
AZUSA, CALIF.—Aerojet-General has delivered the prototype of a lunar gas chromatograph (LGC) system for the *Surveyor* vehicle to Jet Propulsion Laboratory. Evaluation studies of the device are getting under way.

The "moon sampler" is designed to provide information on the composition of non-mineral materials in lunar surface samples, raised to the instrument from depths up to several feet by the *Surveyor* drill.

The LGC is highly specialized in scope as compared to a similar moon soil analyzer to be used in the *Prospector* vehicle payload. But its application —to determine if terrestrial-type life exists or has existed on the moon—is no less important. The results could lead to more positive conclusions to the theory that microorganisms exist in space.

In initial payload design, the LGC was alloted absolute maximums of 15 lbs. and 100 cu. in. in weight and volume. Ten watts of power was all that could be spared. The operational package had to contain all electronics required to process the low voltage supply, operate detectors, and provide outputs of derived information compatible with the telemetry system. In addition, the package had to self-program itself through all operations after receiving a single ON pulse.

During launch and initial climb, the instrument would have to withstand the vibration and acceleration of the landing-vehicle rockets, and 100-g deceleration loads at launching. The predicted 300° centigrade temperature variation on the lunar surface made high component density of electronic circuitry seem practically impossible.



LUNAR CHROMATOGRAPH designed by Aerojet-General is a 12-lb., 675 cu. in. package. With present design, 12 samplings plus one calibration test can be run.

• **Design features**—The Aerojet design wound up as a 12-lb., 675-cu.-in. package—well within the required specifications. Electrical power, found to be insufficient at the original 10 watts, has been boosted to 100 watts by modifications to the *Surveyor* electrical system. The revision now provides enough power to operate the furnace for periods needed at 150°, 325° and 500°C control temperatures.

The volumetric sampler, actuated by an 85-cu.-ft. helium supply in a titanium sphere drops 4 cc of rock particles into the furnace as many times as the gas supply allows. The soil is then heated electrically to one of the three control temperatures to volatilize compounds of low molecular weight and pyrolyze heavier ones.

In the present design, there is sufficient carrier gas for a minimum of 12 samplings plus one calibration test. An original requirement for pulverizing the samples was omitted from the present configuration after it was shown that the drill produced particles fine enough for direct feed to the furnace.

A reduction in the size of valve components in the LGC is another major contribution to design and operation of the complex flow system. Carrier-gas shut-off is handled by a 0.26-lb. double-latching solenoid valve requiring only a brief pulse. Another 0.16-lb. solenoid-actuated valve is used in the analytical valve system. In response to an ON pulse from the programer, the valve operates a piston-cylinder device attached to a ratchet with 30° steps.

Three specially contoured cams are attached to the ratchet through a central shaft. In function, the valve, ratchet and cam assembly operate as four three-position spool valves. System valving setups change with each 30° step—with 12 configurations available during the period of each full analysis.

The programer activates a pneumatic stepper through semiconductor counting and magnetic frequency-dividing circuits. Resistors in the R-C oscillator at each of the 12 steps vary the count rate.

• **Three columns**—To obtain the maximum information from each soil sample, the design uses a three-parallel analytical column system—two columns for partition, the other for adsorption. Anticipating polar compounds in the products of the analysis, one column material is 20,000 molecular-weight polyethylene glycol on Teflon. A second column uses a mixture of neopentyl glycol sebacate and Apiezon L on Chromosorb W; the third column 5A Molecular Sieve. Programed backflushing occurs after a 30-min. analysis period.

The soil samples pass through a thermistor thermal conductivity cell prior to splitting and entering the columns, in order to obtain an approximation of the gaseous sample size. A cross-section ionization cell with a radioactive source of titanium tritide is located at each column exit. These detector types offer large dynamic-sample size range and are relatively insensitive to flow rate and temperature, but other detector types are still under study.

In conjunction with the detectors, electronic systems are typical high-component-density type, and are also used with the spacecraft's 0-5-volt telemetry system. The design incorporates automatic range switching for a three-decade readout.

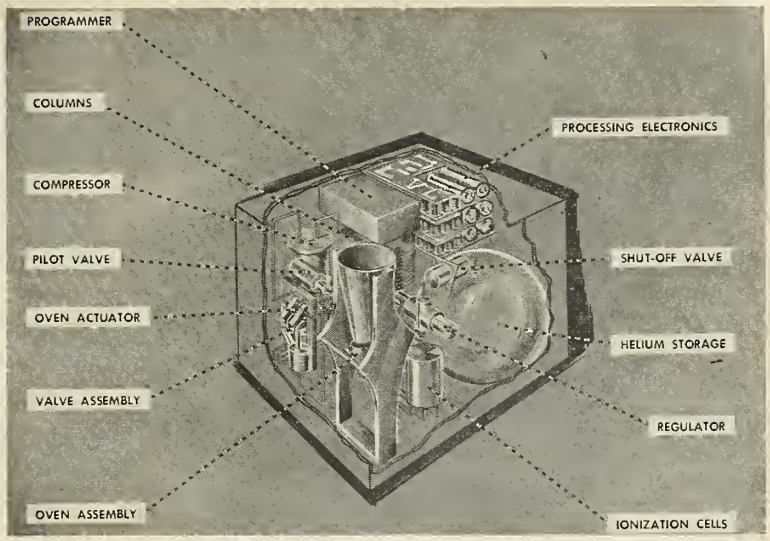
• **'No' answers only**—There is no plan to analyze the lunar atmosphere with the LGC. Since the total pressure of lunar surface gas is theorized to be about 10^{-14} earth atmosphere, Wilson says, other instrumentation is better suited for this analysis. Prime feature of the LGC is its ability to detect, in gas from heated soils, a large number of components from among a wide variety of compound classes.

Verification of theories on moon geology by earth experimentation is unfortunately impossible. The fact that the lunar atmosphere and hydrosphere was lost at a relatively early date, coupled with the belief a protective meteorite layer covers the moon, gives the "on-site" LGC investigations great scientific importance.

The Aerojet LGC design is based on the premise that organic compounds exist within the moon structure. One theory, for example, postulates that 5 to 10 grams of such compounds have been deposited on each square centimeter of the moon and localized within some tens of meters below the surface.

Studies and experiments started in late 1960 indicated that a high degree of scientific information would be obtained—and the presence of characteristic compounds such as acetone and acetonitrile would be detected—if biogenetically derived compounds are present in the lunar soil.

Scientists at both Aerojet and JPL claim that the moon sampler can prove the *absence* of terrestrial forms of life in each sample analyzed. Lack of acetone and acetonitrile after pyrolysis of lunar dust would indicate no alanine was present—hence no evidence of earth-type life. Opposite results lead to the situation where no definite conclusions about "moon-life" can be made. The experiment provides only a positive NO answer for the particular sample being analyzed. ⌘



VEHICLE WAS DESIGNED using premise that there are organic compounds in the moon. Payload, now undergoing tests at JPL, will be included in Surveyor Vehicle.

A New Tool in Space

Gas chromatography is the nearest thing to a universal analyzer yet developed. This is true at least where vaporizable materials are involved. Gas chromatography is a physical separation method in which a solute is distributed between a stationary sorbent phase of large surface area and a mobile gas phase. The mixture of carrier gas and sample flows into a partition column, containing a substance, such as a high boiling liquid in which the materials in the sample have different partition coefficients.

They are retained in the column for different periods of time and travel through it at different speeds. Entering a detector at the end of the column, they register a series of signals resulting from concentration changes and rates of elution.

If a recorder is tied to the detectors, the signals appear on a chart as a chromatogram—a series of characteristic peaks. The appearance time, width and height of these peaks can be measured to give analytical data on the sample composition.

Senate Committee Relaxes Defense Ad Restrictions

THE SENATE Appropriations Committee has opened the door for extensive modification of the House amendment to the fiscal 1962 defense bill which would have eliminated the cost of defense advertising as an allowable contract cost.

An amendment requested by the Dept. of Defense exempting from the restriction advertising costs connected with recruitment for contractor personnel, procurement of scarce materials and disposal of scrap was accepted by the Senate committee. The committee also went a step further to meet industry objections to the severity of the bill by recommending as legitimate contract costs advertisements for the procurement of subcontractors required for the performance of the contract.

The Senate committee said it believed that certain types of advertising by defense contractors in the performance of defense contracts should be considered as an allowable item of cost. It concurred, however, with the expressed desire of the House to end such abuses as including unwarranted advertising as part of the cost of performing defense contracts.

The committee amendment also directs the Secretary of Defense to bar any advertising "which is designed to pirate personnel from one defense contractor by another defense contractor." The two versions next must be reconciled in a joint House-Senate conference. ⌘

'Interconnection' Clears W&C Snarl

by William Gilmour

ON MARCH 27 of this year, MISSILES AND ROCKETS *published a Special Report outlining in detail the "Snarls in Missile & Cable Industry." Among the deficiencies highlighted in this report were the lack of clearcut, definitive standards, poor intra-industry cooperation and the absence of design concurrency between prime contractors and the cable and connector industry.*

The report went on to point out the need for firm standards and "standardization" within the Defense Department. And, although the survey pointed out that much had been accomplished, it made it clear that "all involved in the missile wire and cable business are agreed that more lead time and design concurrence are essential. So long as the cabling is left until last, poor design and problems will naturally result."

The following article shows how one company worked with the military and a special group of "interconnection" engineers to lick the problem of design concurrence.

William Gilmour, the author, is presently a radar project engineer, Wayland Laboratory, Raytheon Co.

ONE OF THE MOST pressing needs in the missile industry is for prime contractors to realize that engineers must be provided to work with cable and connector manufacturers in the initial design stages of a missile system.

As MISSILES AND ROCKETS pointed out in its special report on "Snarls in Missile Wire & Cable Industry" (M/R, Mar. 27, p. 20), contractors seldom include cable and connector specialists until the system design has been already fixed. By this time, it is too late.

This problem was encountered by Raytheon several years ago and was solved only through the use of "interconnection" engineers. These men were responsible for the design and development of inter-unit connections and the choice of the proper interconnecting cable assemblies to meet the system specifications.

The story of the success of this approach graphically illustrates the necessity for early integration of cable and connector specialists in the design and development phases of a weapons system.

When the engineering model of a mobile integrated missile system was first designed about five years ago, the network of interconnecting cable assemblies was selected *after* component hardware of individual units had been designed and partially fabricated.

This led to a tentative choice of cable assemblies using cables and connectors available to meet MIL-C-13777 and MIL-C-5015. However, these were large in number, bulky and far more expensive in both initial cost and logistic complexity than seemed warranted.

The figure shown on pg. 36 gives a graphic example of the system before a team of interconnection engineers examined the problem. Many of the cable runs are broken into three assemblies to meet the performance required by MIL-C-13777—specifically, that the maximum footage on a reel was limited to one-third of the cable weight and size.

At this point, the Army Rocket and Guided Missile Agency (ARGMA) requested that a detailed study be made of the fabrication and logistic problems of storing, sorting, laying and correctly connecting the 69 cable assemblies, as well as the number of men and vehicles necessary to accomplish this under tactical conditions, and the adequacy and reliability of these assemblies.

• **Study approach**—The initial design of these units was such that practically every unit had a cable "entrance area." And, since these areas would be the only part of the individual units that would have to be redesigned, the interconnection engineers would have almost a free hand in solving the problem.

In addition to the twist, bend and impact tests of the cable required by MIL-C-13777, the following tests were devised jointly by Raytheon and a special Frankford Arsenal evaluation group:

—Coaxial cables were tested under loads simulating actual usage.

—Cable assemblies were tested for feasibility of connecting and disconnecting at low temperatures under simulated field conditions, as well as being tested for a watertight seal between connector and cable.

—Assemblies were reeled and unreeled at low temperatures under field conditions to determine the best field-handling methods and the time required for these operations.

—Cable system identification markings were discussed to determine whether coded numbers, letters or painted stripes should be used.

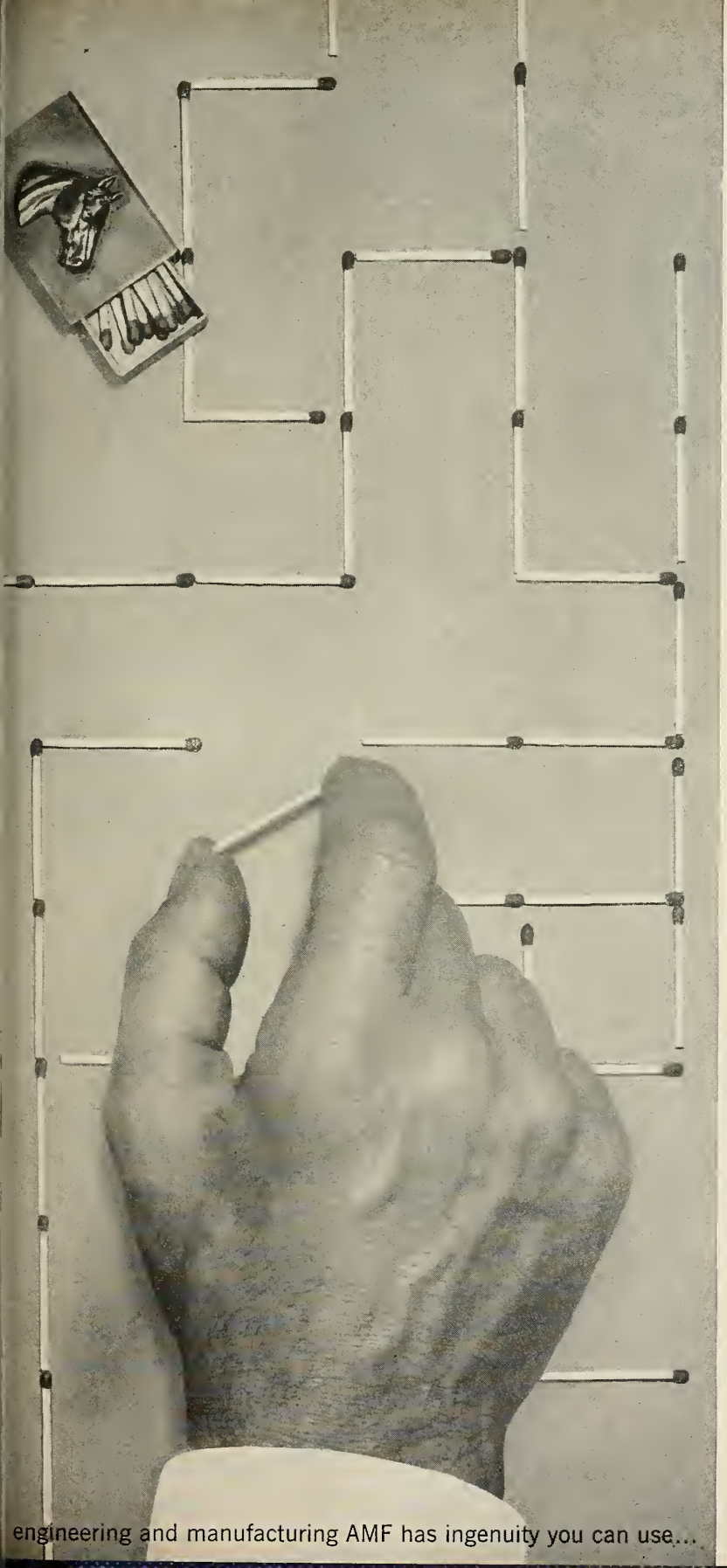
• **Results**—One immediate conclusion of Frankford Arsenal's evaluation was that the cables were designed without due consideration of their diameter and weight.

Using data from many knowledgeable sources—including Frankford Arsenal, Raytheon field engineers, and the cable and connector companies involved—the interconnection engineers analyzed every load of the battery's cable system. Taking into account the voltage, current and shielding necessary for each cable and connector, the interconnection specialists evolved a practical means for improving the cable system.

This improvement took into consideration the customer's desire for both a foolproof cable system and logistic simplicity.

• **New cable philosophy**—As a result of this study, a new cable philosophy was proposed for the system at a Raytheon interdivisional conference:

—All cables between units must be single runs to eliminate the confusing



engineering and manufacturing AMF has ingenuity you can use...

He designed a new interchange for radio traffic

This AMF engineer, part of an AMF-U.S. Army team, solved the problem of traffic delays and personal danger in manual re-connection of jumpers when interchanging R.F. transmitters and antennas.

His solution is a push-button-operated, coaxial crossbar switching system, using vacuum switches for circuit selection. A typical system consists of 4 transmitter inputs, 7 antenna outputs plus a dummy load, in a 4 x 8 matrix that can be mounted in a 19″ rack. It can be controlled locally or remotely over any type of communication network having a bandwidth of at least 200 cycles.

AMF's coaxial crossbar switching system provides 100% flexibility in circuit path selection and accommodates power levels as high as 500,000 watts and frequencies up to 30 megacycles. It allows 100% utilization of all transmitting equipment. Stubs are automatically eliminated.

To insure fail-safe operation, power is required for the vacuum switches *only* during change of condition. Selection rate: 1 per second. Operating transmitters are safety-interlocked to insure a load. There are no hazards from open wires or inadvertent application of power to dead-lined antennas.

Single Command Concept

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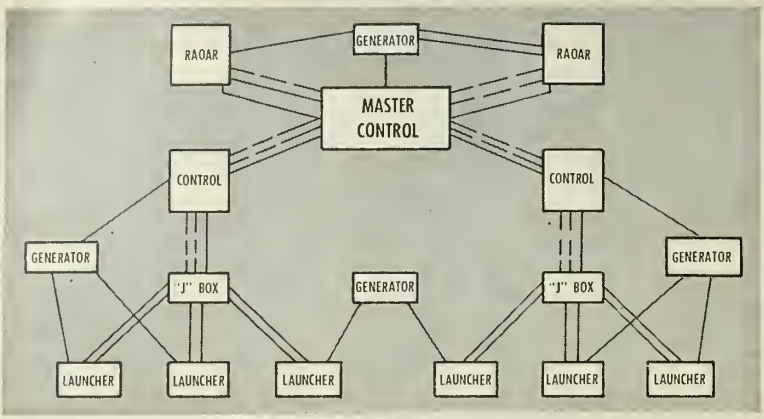
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CABLING PROBLEMS of tactical missile systems are graphically portrayed by the diagram above. The complement of cable assemblies per system consisted of 69 cables, 12 different cable types and numerous multi-runs. This was before the problem was examined by Raytheon's Interconnection engineers.

possibility of cross-coupling midpoints of multirun cables. This is contingent on development of a new cable weighing less than 450 lbs. per 1000 ft. and having a diameter of approximately one in.

—A cable design containing the optimum number and type of conductors for this specific application must meet the performance requirements of MIL-C-13777.

—A simple system of electrical polarization is required to enable all data cable assemblies to be identical and to eliminate all route or destination markers.

—Cable assemblies can then be reduced from twelve to two: one for power and one for data.

—The power cable was to be a standard four-conductor cable type, but the diameter and weight was to be minimized.

—The data cable must contain the necessary conductors for control, synchro, video, trigger and even telephone circuitry. The requirement for light weight and minimum size puts this specification beyond the present state of the art of the cable industry.

• **New materials**—These recommendations forced Raytheon Engineers to consider new primary insulation materials not previously approved by Army Ordnance in MIL-C-13777.

These new materials would be necessary to ensure that the diameter of the finished cable would not exceed one inch—the maximum diameter to fit 375 ft. of cable onto the specified Ordnance reel—while the weight of the loaded reel would not exceed 170 lbs.

Although the cable was to contain 34 single, two sets of triple, and two 75 ohm coaxial conductors, the reinforced steel strands in the conductors and the reinforced artic neoprene jacket were still considered necessary for long field life.

After many tests on proposed cable materials, polyethelene—conforming to Specification L-P-590 (Type II-Grade 4 or 5)—was found to equal in many respects the performance of the usual latex or rubber insulation compounds. It proved to be superior to these compounds in cold-temperature handling tests at −65°F. If this material was to be used, however, cable companies had to perfect a low-temperature cure for the outer jacket of Artic Neoprene.

• **Connectors also studied**—Along with the modifications outlined below, a one-piece insert with a positive interfacial sealing action in a heavy-duty, machined, waterproof connector was proposed. Other recommendations were:

—A new insert style with 40 #20 and 2 coaxial contacts to accommodate the new data cable.

—A jamnut receptacle for ease in the unit harness assembly.

—Complete ejection of the plug from the receptacle by the coupling ring.

—No contacts making connection until polarizing bosses and grooves have properly oriented the inserts.

—A modified double-stub thread for quickness of mating and disconnecting, ease of cleaning, prevention of cross-threading and resistance to loosening under vibration.

—A waterproof cable clamp adapter specifically for the cable outer diameter, with a cable-strain relief to eliminate strain on the contact solderwells, and with a left-hand thread to prevent inadvertent wringing of the conductors from the solderwells by field personnel loosening the wrong joint.

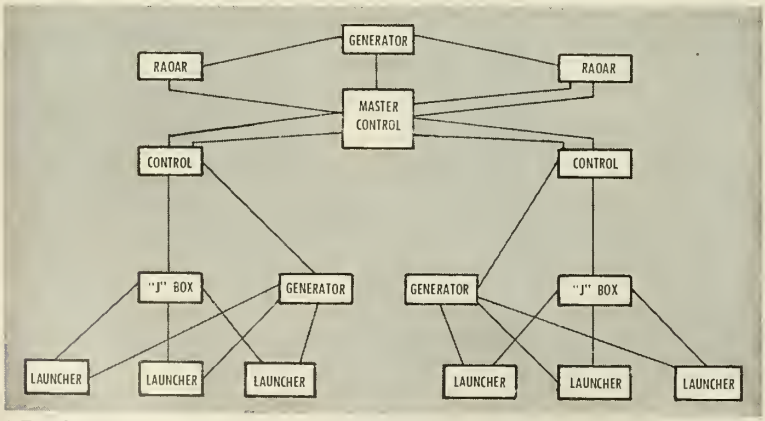
—Caps retained by a wire rope with a breaking force of 100 lbs. to prevent RF interference that exists with caps of the more popular beaded chain.

• **MIL-C-13777 revised**—As this program moved toward completion, a cable conference was held at Frankford Arsenal for representatives of the manufacturers, the military and users. The purpose of this conference was to revise the military specification (MIL-C-13777) to allow the inclusion of the materials that the Raytheon/Frankford tests has proven suitable for cable use.

The changes incorporated into the specification included: permitting materials other than latex or rubber for primary conductor insulation, elimination of the previously required identification groove, tightening of the specification "torture tests" to more adequately simulate field conditions, and specifying definite design requirements for the inclusion of coaxial conductors to meet the same operational requirements as the conductors of the power and data cables.

• **Marked improvement**—As shown

(Continued on page 57)



REDESIGN EFFORTS yielded many important results as shown in the diagram above. Multi-run cables were eliminated; the number of cable assemblies per system was reduced to 29; and the number of different assembly types to two—one for power and the other for data.



SCIENTISTS AND ENGINEERS:

Follow-On Atlas Programs Mean New, Long-Range Opportunities.

Now operational, the Atlas weapon system stands as a unique symbol of scientific, engineering and military achievement. The design, development and testing of this reliable missile was an undertaking of immense complexity.

Scientists and engineers at Convair/Astronautics worked constantly at the most advanced state of the various arts involved. Boldly, they introduced and proved entirely new concepts of rocketry, and in record time they developed the Atlas.

The same depth of imagination and technical daring is now at work modifying and adapting this sophisticated machine for a variety of civilian and military space missions. Dozens of specialized orbiting and inter-planetary vehicles will depend upon the power of Atlas to thrust them into space.

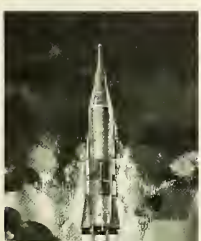
These programs reach far into the future and require the skills of highly resourceful engineers and scientists in many technical disciplines.

Atlas is the free world's first intercontinental ballistic missile; the first missile to travel more than 9,000 miles across the earth's surface; the only one to lift itself into orbit. Atlas marked the first use of swivel engines for directional control and it was the first to use airframe skins as fuel cells.

Many more "firsts" lie ahead for this reliable rocket. If you are the sort of inventive engineer or scientist who can contribute ideas and solutions to the problems surrounding the mastery of space, you and Convair/Astronautics have a common interest.

You'll find most of the details on this and the following page, plus a convenient inquiry card. If the card has been removed, or if you wish to furnish or request more detailed information, write to Mr. R. M. Smith, Industrial Relations Administrator-Engineering, Mail Zone 130-90, Convair/Astronautics, 5674 Kearny Villa Road, San Diego 12, Calif. (If you live in the New York area, please contact Mr. T. Cozine, manager of our New York Placement Office, 1 Rockefeller Plaza, CIrcle 5-5034.)

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Convair Astronautics is located in San Diego, California, the third fastest growing community in the United States. It is situated 10 miles north of the Mexican border and a little over 100 miles south of Los Angeles.

Immediate openings exist in the following areas:

SCIENTISTS & ANALYTICAL ENGINEERS with Ph.D or Sc.D for electronics and physical research; computer analysis and application; and instrumentation development.

ELECTRONIC DESIGN & TEST: communication systems and data transmission design; logical circuitry; automatic control systems; and electronic packaging. BSEE plus appropriate experience required.

MECHANICAL DESIGN: BSME or AE for pneumatics, hydraulics, and fluid systems design and test. Also missile GSE and missile structures designers.

RELIABILITY ENGINEERING San Diego openings exist for experienced engineers with applied higher mathematics education, preferably in statistics; higher degrees preferred. Circuit analysis with transistor and diode experience is also desirable.

PERSONNEL SYSTEMS (MAN/MACHINE ANALYSIS) Specialists capable of evaluating the personnel function from a systems standpoint. Requires analytical approach to applying manpower to an existing system at the customer level. Broad technical systems background, with emphasis on human relations is essential. Assignments involve analysis of manpower requirements and applications for a weapon system, including equipment, procedures, time studies, logistics and training. Degree required, preferably in industrial engineering, business administration or industrial psychology.

ENGINEERING WRITERS with 2 years college and 1-3 years experience in preparation of TCTO's; Operations, Maintenance, and Overhaul manuals.

BASE ACTIVATION: Design or liaison engineers with BS in ME or EE and experience in electrical or mechanical systems are required for liaison work at missile launching complexes, or design support work on launch control equipment, propulsion systems, automatic programming and missile checkout equipment operations. Assignments are at Salina, Kansas; Lincoln, Nebraska; Altus, Oklahoma; and Abilene, Texas. Also some openings in San Diego.

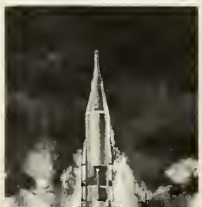
FIELD TEST ENGINEERS: Electrical engineers for test and validation of complex power electrical systems using standard commercial equipment. Troubleshooting and checkout of ground electrical equipment including lighting, systems through missile-borne power distribution, fire alarm instrumentation and control. Must be thoroughly familiar with motor generators, motor control centers. AC and DC power and control circuits. Openings at Vandenberg and Edwards AFB, Calif., Cape Canaveral, Fla.

If you desire to become part of this great team, we urge your prompt inquiry on the attached Engineering Placement Inquiry.

Technical openings also exist in other specialties. Write Mr. R. M. Smith, Industrial Relations Administrator-Engineering, Dept. 130-90, Convair Astronautics, 5674 Kearny Villa Road, San Diego 12, California. (If you live in the New York area, please contact T. Cozine, manager of our New York placement office, CIrcle 5-5034.)

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CONVAIR / ASTRONAUTICS



CONVAIR DIVISION OF GENERAL DYNAMICS

MA Getting 11-in. Flight LOX Valve

Unit with 6500 gpm capacity flow weighs only 50 lbs. —designed specially for manned orbital flight

THE LARGEST FLYING LOX valve in the world will be aboard the *Atlas* booster that puts the *Mercury* capsule into orbital flight.

The unit, with an 11-in. line diameter, and weighing only 50 lbs., was developed by the Components Dept., Reaction Motors Division, Thiokol Chemical Corp., for the *Mercury Atlas* series.

Before Thiokol delivers the valves, they are pressure-tested, vibrated, cycled, flowed, subjected to extreme environmental conditions and spun on a special horizontal centrifuge at simulated accelerations exceeding 130 g.

In operation, the forward valve section is bolted to the missile sustainer and the aft valve section fastened to the "booster" stage of the *Atlas*. At stage separation, the aft valve section is pulled out of the forward segment, permitting a poppet to be forced shut by spring force and fluid pressure. A by-pass continues to feed LOX to the sustainer engine.

The aft section holds the spring-loaded poppet open while the valve parts are mated. This section also absorbs the stress and misalignment generated during flight.

The forward section, constructed from spun and brazed aluminum, consists of body, ring and poppet assemblies. The body assembly includes integral guide vanes with a centrally located tube which serves as a poppet guide and spring housing.

The ring assembly, bolted to the body assembly with a spirally wound gasket at the joint, has a tapered mating edge to permit ready engagement of the aft section. The poppet assembly, spring-loaded in the closed position, includes a pilot valve assembly and a Teflon gasket which forms the seal. Upon disengagement, the forward section seals closed when the gasket on the poppet seats against the ring assembly.

The aft section is composed of a stainless-steel bellows assembly and a spun-aluminum spider. The bellows portion includes a bellows welded between two flanges, the aft drilled for booster fastening and the forward drilled for spider attachment.

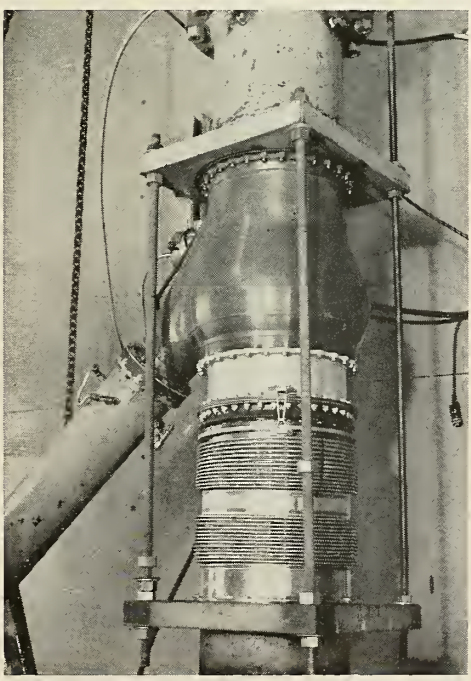
A spirally-wound gasket forms a seal between the spider and bellows. Excessive compression is prevented by positive stops on three stainless rods between the bellows flange and the spider assembly.

• **High flow**—The entire valve has an unusually high total flow capacity of 6500 gpm at 117 psig. The sustainer by-pass has a capacity of 1180 gpm at 117 psig. Flow through both outlets occurs with a pressure drop of 3.8 psi in the booster line and 3.0 psi in the sustainer line. The unit disconnects and separates in 0.04 seconds.

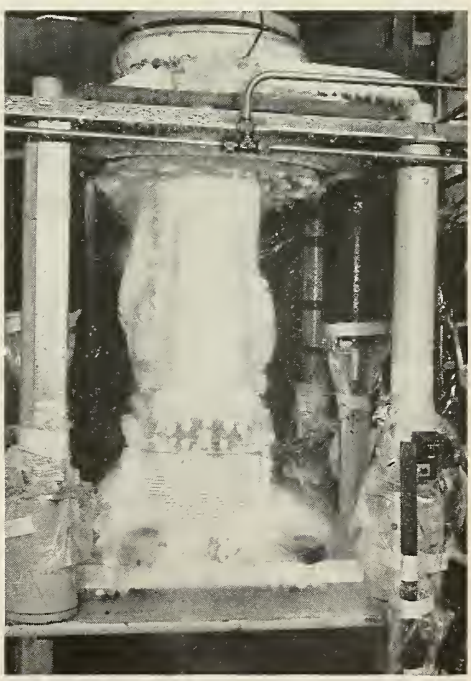
The *Mercury* valve meets Air Force specifications and is an off-the-shelf item. It can be modified to meet other requirements.

The Reaction Motors department produces a complete line of valves including disconnect, shutoff, check, and fill-and-drain. Vent and relief valves, reusable squib valves, universal fluid couplings and gas-pressure regulators fill out the firm's line.

The components have been used in *Viking, Titan, Atlas, Thor,* Project *Mercury, X-15, Redstone, Jupiter C* and in the Bell X-1, BX-1A and MX-774. ¤



LARGEST LOX disconnect valve produced by Reaction Motors has a line diameter of 11 in. The unit is being used in the Mercury-Atlas series.



SEVERE ENVIRONMENTAL testing has paid off in extremely high reliability. Components are subjected to special evaluation testing before delivery.

Dyna-Soar 'picks-off' X-15 hardware...

(Continued from page 14)

part of the job formerly done by the nose boom, providing air flow information. Its main feature is a 5½-in., hollow, nitrogen-cooled shell made of Inconel-X which varies down to ½-in. in thickness. The ball presents five holes—four placed 42 degrees off a center hole—to the air stream. Sensors detect pressure differentials across the holes, and a servo rotates the ball to keep the central orifice lined up with the relative air flow, equalizing pressure on the outer holes. Ball displacement from the aircraft's center line provides angle of attack and yaw information.

Although the critical job of the nose ball is re-entry, it is necessary over the *X-15's* entire flight profile above Mach 3.5. On re-entry, the pilot uses the ball to establish and hold his re-entry angle. Re-entry angles—aircraft angle of attack as measured from direction of air flow—have ranged up to 12 degrees for the *X-15*, depending upon peak altitude.

• **Data lag**—The *X-15*'s inertial platform probably will be the most direct application to *Dyna-Soar*. In addition to inertial attitude, it provides the other data lost when the nose boom was removed—velocity and altitude.

"We couldn't trust the nose boom for air speed, attitude and altitude after the *X-15* reached Mach 3.5 because of boom heating and the *X-15*'s rapid changes in altitude," says one project engineer. "And there was too much lag in obtaining this data."

The inertial platform and the nose ball are tied into the oscillation-damper—the stability augmentation system—which *X-15* pilot John McKay called "the last resort to keep the airplane from breaking up during certain maneuvers."

"What we have found is that it takes such a system to get the pilot through troublesome flight areas," McKay said. "Otherwise, some maneuvers would result in oscillations too great for the pilot to handle." He added that the stability augmentation system, as well as the *X-15*'s design, made the aircraft somewhat easier to fly than the *X-1, X-1B, X-1E,* or *D-558 Skyrocket.*

The *X-15*'s stability augmentation system is unique in that it has a variable gain, or response rate, which is needed because of the aircraft's extremely variable flight condition. The pilot adjusts the gain for altitude, air speed and dynamic pressure, making the aerodynamic controls react slower or faster, as needed.

Love said *Dyna-Soar* would require an improved system which will tie into the ballistic controls (the present system does not) and automatically adjust its own gain with information from the inertial platform and ball nose.

An advanced system, known as an adaptive control system and designed by Minneapolis-Honeywell, is scheduled for installation in the No. 3 *X-15* for October flights. It already has been tested in the *F-101* and *X-15* simulator.

McKay reported the adaptive control system has better fail safe features than the system currently in use, automatically going to a fixed-gain setting to allow the aircraft to return safely in event of system failure.

"The No. 3 *X-15* will test this system for other programs as well as *Dyna-Soar,* including supersonic transport and low-level attack aircraft," Love said. "It's being looked at for a variety of vehicles. It seems to be the general trend."

• **Skin problem**—The *X-15*'s side-arm controller concept definitely is slated for *Dyna-Soar* use.

What *Dyna-Soar* will use for skin has not been released, but one *X-15* modification, currently underway, will be noted by the military vehicle's airframe designers. The *X-15's* side fairing panels buckled during a recent mission because of non-uniform temperature stresses. There are four such panels, 2-ft. long triangles, on each side of the fuselage over the liquid oxygen tank forward of the wing. They are fabricated from two pieces of .030 Inconel-X, the inner piece corrugated. The panels are subject to below-freezing temperatures on the inner side and aerodynamic heating on the outside.

The modification involves installation of expansion joints between the panels. The supports to which the panels formerly were riveted now have been V-slotted, and the panels attached with pins which allow a ¼-in. expansion through the slot.

The *X-15* so far has had more trouble with temperature stresses than with air loads, though nothing unexpected or serious. The aircraft is equipped with 650 thermocouples to record how heat flow lags through its structure. In the wings, for example, the temperature might reach 400 degrees F. on the lower surface, drop to zero inside and rise to 200 degrees F. on the top surface. Such differentials, added to air loads, could lead to warping, rivet-shearing and structural failure.

The auxiliary power unit is another



Assignment: manufacture star-shaped flame shields, heat shields, and other important structures for NASA's Saturn booster. That's only one side of the Lockheed/Georgia aerospace story. We offer space-oriented research (cryogenic lab, hypersonic shock tunnel, human factors). We know how to build huge structures. And we're at the hub of the Strategic Southeast—practically next door to Huntsville and Cape Canaveral. LOCKHEED/GEORGIA

Marietta, Georgia

X-15-proven feature that will go into the space bomber. However, *Dyna-Soar* will take advantage of state-of-the-art improvement in hydrogen burning, using hydrogen and liquid oxygen as its APU energy source. The *X-15*'s two APUs operate on steam power produced by hydrogen-peroxide.

One of the main reasons for this difference is that the hydrogen-liquid oxygen system will weigh less. But perhaps even more important to *Dyna-Soar*, the hydrogen-liquid oxygen, kept at −300F., will be used as a heat sink.

• **Wire skids**—Although *Dyna-Soar* will use different landing gear, *X-15* research is providing vital information in that area as well. The *X-15* is equipped for dry lake bed landings, using smooth rear skids and a non-steerable nose wheel, whereas *Dyna-Soar* will use wire brush rear skids and a dish-type front skid for landing on asphalt or concrete runways.

Both *Dyna-Soar* and the *X-15* pilots have been investigating ground steerability during landings, using the aerodynamic controls to shift load to one skid or another for directional control. In the case of the *X-15*, this is being investigated for emergency landing procedures when it might have to land at an alternate dry lake.

Love spiked a recent report that the *X-15* would be used to test *Dyna-Soar*'s brush skids. The brushes will be tested on a truck that will speed up and down a runway. The *X-15* is strictly for dry lake bed landings.

The *X-15* will soon begin testing two new devices that will provide further information, and possibly hardware, for *Dyna-Soar's* pilot environmental system—a radiation counter and a gas analyzer.

The radiation counter is a 15-lb. package developed in-house at the Air Force Special Weapons Center, Kirtland AFB, N.M. It will measure the rate of radiation experienced by the pilot at higher altitudes.

The gas analyzer, developed by Bendix, will be essential equipment on any spacecraft. It will sense and report partial pressure of five known gases—carbon dioxide, carbon monoxide, oxygen, water vapor and nitrogen—and, by scanning atomic numbers, note the presence of any "unknown" gas in the environmental system ⌗

Saturn C-2 booster dropped . . .

(Continued from page 13)

becomes operational in time.

NASA is expected to publish the proposed *Saturn* changes once its $1.8 billion appropriation bill clears Congress—expected in about two weeks. Meantime there were these other developments in the *Saturn* program:

There will be no modified *Centaur* third stage on the first generation *Saturn C-1* booster. Since the *C-1* will be used only for development testing and earth orbit shots of *Apollo*, NASA has decided that a two-stage vehicle will be sufficient. Money saved from the cancellation of the *C-2* and the *Centaur* stage will be used to speed up other aspects of the program.

• **C-1 competition**—A bidders conference will be held late this month on construction of some 15 *Saturn C-1* boosters. First developed by the Marshall Space Flight Center, the space agency is now ready to turn construction over to industry.

Competitors for the multi-million dollar prime contract include Convair, Martin, Chance-Vought Aircraft Co., North American Aviation, Boeing, Aeronutronics, and Chrysler.

Although several sites have been studied, Marshall Space Flight Center has decided that the *C-1* should be built at a government owned plant at Michaud, La. The same facility will be used for the production of the *S-1* first stage of the *Saturn C-3*. The plant is not large enough to be used as the construction site for *Nova*.

Space agency officials believe that it is impossible to accelerate the development of the *C-1*. They intend, however, to increase its utilization.

NASA originally expected to use three operational *C-1's* for various *Apollo* missions and its satellite programs. This has been increased to at least six and possibly 10. With 10 vehicles scheduled for use in research and development, this means that about 20 *C-1's* will be built.

• **More Saturn pads**—Construction will begin next month on another *Saturn* launch complex with two pads, and there are plans to bring the total to six. They will be used to cut the development test flight period of the *C-3* from 2½ years for *C-1* to 1½ years.

Contract for the *S-II* second stage of the *C-3* will be awarded within the next two months. Firms in the running include Aerojet, Douglas, North American Aviation and Convair. The contract has been delayed by NASA changes in specifications—including three changes in its diameter.

Perhaps the largest decision expected within the next month concerns just what complex of engines and stages will make up the *Saturn C-3*. A large part of the $224 million earmarked for the *Saturn* program in fiscal 1962 will be spent on *C-3*.

As first conceived the *S-1* first stage was to have two *F-1* engines, which develop a thrust of 1.5 million pounds each. NASA is now considering increasing the number of engines to perhaps four. James Webb, space agency administrator, said recently that he favors a three-engine first stage.

The *S-II* second stage will use Rocketdyne's 200,000 lb. thrust *J-2* engine. The big question is will the stage have four or eight *J-2s*?

The *S-IV* third stage contract has been awarded to Douglas and is scheduled to have six 15,000 lb. *LR-115* engines. There is sentiment within NASA to switch one one *J-2*. If this is done, which appears unlikely, it may be necessary to rebid the contract.

Another still undetermined policy decision is how fast development of the multi-billion lb. thrust *Nova* booster should be pushed. Certain government officials feel that the *Saturn C-3* should be stressed at the present time. Another look could be taken at the *Nova* situation in about a year when some unknowns concerning multi-stage boosters have been cleared up.

Although only $48 million of the space agency's fiscal '62 budget is slated for the liquid *Nova* program, it is expected that a decision will be made to push ahead on both programs. Officials contend the total cost will be only 15 per cent higher.

Expenditure of *Nova* funds in the current fiscal year will be limited to planning and selection of firing and launch sites.

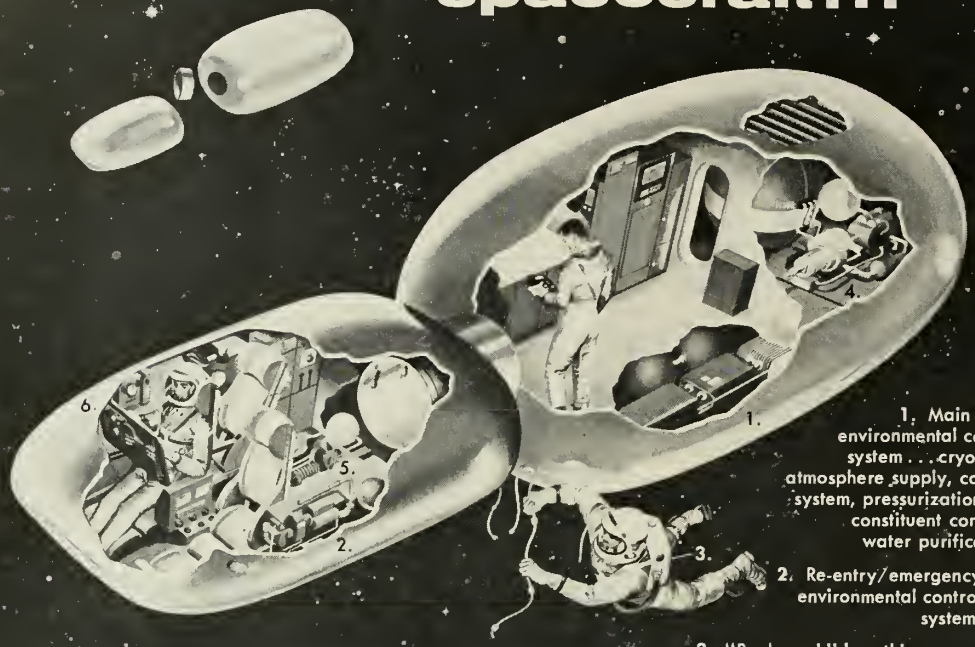
Presently being considered as sites are a great stretch of the Texas Gulf coast and eight or ten other areas in this country and overseas. These include a region within the King Ranch in Texas, White Sands Proving Grounds in New Mexico, the Hawaiian Islands and Christmas Island in the Pacific.

• **First C-1 Launch**—Meanwhile, the space agency began to put into operation plans to launch the first *Saturn C-1* from launch complex 34 at Cape Canaveral. The booster was expected to start its trip down river on a barge either late last week or early this week.

The trip from Huntsville, Ala. to the Cape is expected to take 30 days with the launch set for sometime in October. Ten research and development flights from the Cape are planned with the last four scheduled to test fly the *Apollo* spacecraft.

Marshall Space Flight Center employes have been running the *C-1* through a series of dynamic tests. ⌗

Environmental and secondary power systems for multiman spacecraft...



1. Main cabin environmental control system . . . cryogenic atmosphere supply, cooling system, pressurization and constituent controls, water purification.

2. Re-entry/emergency environmental control system.

3. "Back pack" breathing and pressurization system.

4. Secondary power system . . . multiple re-entry turbine, pump, alternator and cryogenic fuel supplies.

5. Attitude control system . . . reaction motor, fuel and attitude controls.

6. Instrumentation . . . flight data and physiological monitoring systems.

Manned space flight requires reliable and efficient thermal and atmospheric systems and secondary power equipment.

Complete and integrated systems, as pictured, are being studied or under development at The Garrett Corporation. Through optimized design they offer an unmatched degree of compatibility and high performance.

Their design reflects Garrett's 20 years of leadership in developing and producing secondary power and environmental controls for aircraft and spacecraft, including NASA's Project Mercury life support system. This unique capability offers an unequaled source of research, development and production to the government and industry.

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Solar Flare Warning System Unveiled

Lockheed concept could warn of solar bursts far enough in advance to save payloads, warn space crews of danger.

LOCKHEED AIRCRAFT Corp. is offering the Air Force and NASA a project leading to a world wide automatic solar flare warning system for space crews.

Gerald F. Anderson of the Lockheed Solar Observatory, Burbank, Calif. told M/R the proposal is based on recent observational developments which indicate "We are close to a reliable short term method of predicting flare minutes and hours ahead of time."

The ground-based system would be used in an electronic scanning setup to monitor constantly a television image of the sun disk for certain flare indications. Lockheed already has such a monitoring system in operation in Burbank.

While intended primarily to warn these crews of impending deadly outbursts of solar radiation, the system would have an immediate payoff for current satellite research programs.

"In the *Discoverer* satellite program, for instance, they have had experiments wrecked by solar flares," Anderson said, "Emulsion film, radiation counters and telemetering systems have been affected. Scientists would like to recover the payload before this happens. And experimenters in other programs would like to be able to calibrate their satellite instruments to take solar flares into account."

Anderson, who delivered a paper at the American Astronautical Society San Francisco conference, said that a network of four solar monitoring stations around the world could be established for relatively little expense—about $250,000.

The solar flare prediction, using a heliograph equipped with a birefringent filter is based on observation of short term disturbances visible on the sun disk. The disk image may be viewed directly, displayed on a television screen or recorded on a sequence camera which takes one picture every ten seconds.

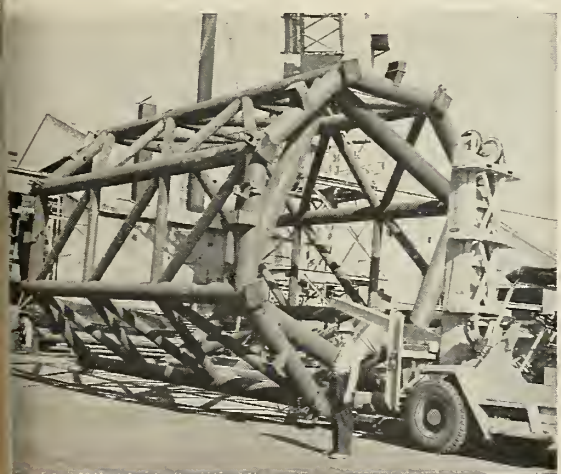
Anderson said he had observed two kinds of disturbances preceding solar flares—a dark crescent shaped area which resembles fingernail marks on the sun's disk, and "filament activations" which appear as small wavy lines.

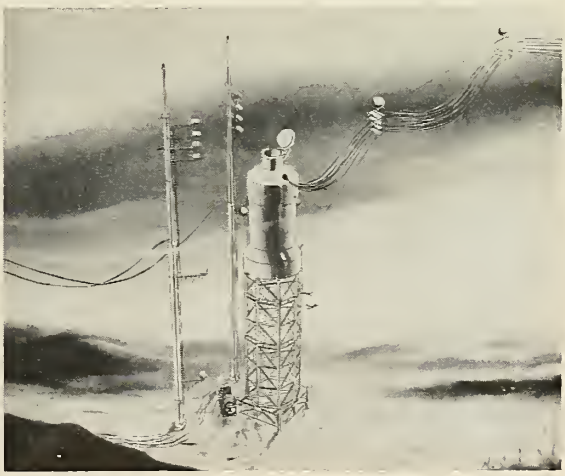
"As you watch, you can see the crescents appear, grow and change shape," he said. "They expand for five or six minutes and then start to break into smaller portions. There are turbulant-like motions. This lasts for a few minutes and then the flare comes. We feel pretty confident that the crescents are disturbances welling up from the sun's lower atmosphere. Flares come up under or very near the crescent."

The filaments, actually the prominences otherwise seen at the edge of the sun's disk, also are associated with flares, sometimes disappear abruptly as little as three minutes before a flare appears nearby.

Anderson said he had not been able to detect advance warning for all flares but that he hoped to do so with the cinematographic system of greater spatial resolution currently under design and construction at the observatory.

Lockheed proposes to establish the system in two steps. In Phase 1, Lockheed would demonstrate for a period of time with an operating system at Burbank. In Phase 2, the stations located around the globe would spend a year taking photographs to demonstrate "seeing" quality before setting up the automatic flare warning system. ⌘





Underwater Polaris Launch Facility

THIRTY-FOOT section of variable depth launcher was fabricated by U.S. Steel's Vernon Plant. Completed facility has been installed at San Clemente Island on the ocean floor and will be used for Polaris testing by NOTS, Pasadena.

ARTIST'S CONCEPTION shows launcher in place at the undersea San Clemente Island Test Range. Movable platforms enable test firing of the Polaris from various depths with high-speed underwater cameras recording trajectory data.

Rocket Power Ranks Abroad Rapid

M/R survey shows 28 nations now participating in space, missile research; European satellite spurs interest

by Bernard Poirier



CENTAURE: Shown being founched from mobile carrier for flight over the Saharo Desert.

A SURVEY by MISSILES AND ROCKETS shows a total of 28 countries now acquiring rocket power—either themselves or through international agreements.

Most of the rocket effort is military oriented. But a growing number of nations are moving into space research, helped along by the United States and the cooperative European satellite launching project. Canada and Britain hope to join the U.S. and Russia with satellites in orbit next year through NASA's International Programs Division. The space agency will provide the launch vehicle for an all-Canadian made *Alouette* satellite. Britain will provide just the instrumentation for its first orbital venture.

None of the space programs now envisioned will approach the magnitude of either the U.S. or Russia. Nevertheless, the joint European program which brings together Britain, France, West Germany, Italy, Switzerland, Austria, Norway, Denmark, Sweden, Belgium, Netherlands, and Spain promises to cost $200 million.

Britain and France, moreover, are considering a plan advanced by SEREB and the Hawker Siddeley Group to cooperate on a communications satellite system which would be operative by the end of 1964. France disclosed this past week that if this plan falls through, she will orbit a satellite by herself in the same time period.

Israel, Yugoslavia and the United Arab Republic have scientific programs underway which could easily be converted to military systems by substituting warheads for instrumented cones and adjusting launching modes.

• **NATO production** — Belgium, Portugal, Denmark, Greece, Netherlands and Turkey are involved with other NATO partners in joint production of *Sidewinder* and *Hawk* missile systems in Europe. Netherlands excepted, they do not produce rockets on their own but in some cases produce highly complex electronic support equipment. The Dutch are producing SEPR rocket boosters for a new military drone under special license with France.

Norway has developed a complete ASW shipborne missile system using the *Terne* weapon and also participates in NATO missile system production

Sweden has several ship and surface-to air missiles operational and hopes t start a sounding probe series this yea with imported research rockets. She ha Hughes *Falcons* deployed and severa British missiles for training purposes.

Red China is believed to be manu facturing JATO boosters for Russia supplied jet fighters and has probabl developed other rockets.

Madrid sources say the Air Force Ministry has several missile researc projects underway. A group of scientist have launched several small researc rockets and a stronger program remain stalled by the lack of national backin for non-military projects.

In Baghdad last month, Iraqi troop had a show of military prowess whic included several mobile barrage rocke launchers similar in design to the *HR* rocket system purchased by Egypt fron Italy several years ago. But in the Nea East other "neutral" nations are gainin in rocket powered hardware. Iran con tinues her interest in several system since the French demonstrated the antitank missiles in Mehrabad last yea

• **UAR joins in**—The imbalanc caused by rocket power was demon strated when Israel launched her *Shav II* which, according to observers in T Aviv, has a 62 mile range tactical ve sion under development. The relatively simple event prompted the United Ara Republic into urgent procurement American research rockets.

While Israel's initial effort resulte in releasing a sodium cloud at an e treme altitude the implication that Isra had achieved rocket power as an instr ment of war caused an instant respon in Cairo.

The UAR imitated Israel and cite peaceful applications for the newly a quired rockets. No public mention w made by the UAR of the rocket studi at Heliopolis which have been pursue for several years by Egyptian scientis attached to C.E.R.V.A., Company f Accelerated Flight by Reaction V hicles.

Although the U.S. and the USS dominate the field, France and Engla are neck and neck on overall develo ment for third place and the remaind trail behind at various levels. Consid ing size and population several natio are making outstanding contributions.

• **Down-under research**—Austra

ncreasing

has her own research rockets and has a major installation to support NASA's man-in-space program. Canada is developing the *Black Brant* rocket series and her *Alouette* satellite will be orbited by NASA early in 1962. Canada has no military missile programs of her own but Australia has its *Malkara* antitank missile.

Japan's outstanding research program is centered in the Itokawa Laboratory at Tokyo University while its Defense Ministry manages all military missile research and production. Professor Itokawa's best effort to date occurred April 1, 1961 when the new *Kappa 9* was successfully launched at Japan's Akita Test Site and all three stages ignited perfectly for an ionospheric sounding at 250 miles altitude.

Yugoslavia purchased $277,000 worth of earlier *Kappa 6* rockets and necessary ground support equipment as its first build-up of a national effort in rocket know-how. Even remote Burma is making a pitch for Japanese research vehicles as is Australia and Argentina which has several successful rockets of its own.

Britain has the only inertial guidance systems in operational missiles outside the U.S. and USSR. On the research side, Britain has used the *Skylark* more than any other vehicle. A recent shot released a sodium vapor cloud at 110 miles over Woomera, Australia, and plans now call for ultraviolet photos of stars utilizing the *Skylark* in a program financed by the Royal Observatory, Edinburgh.

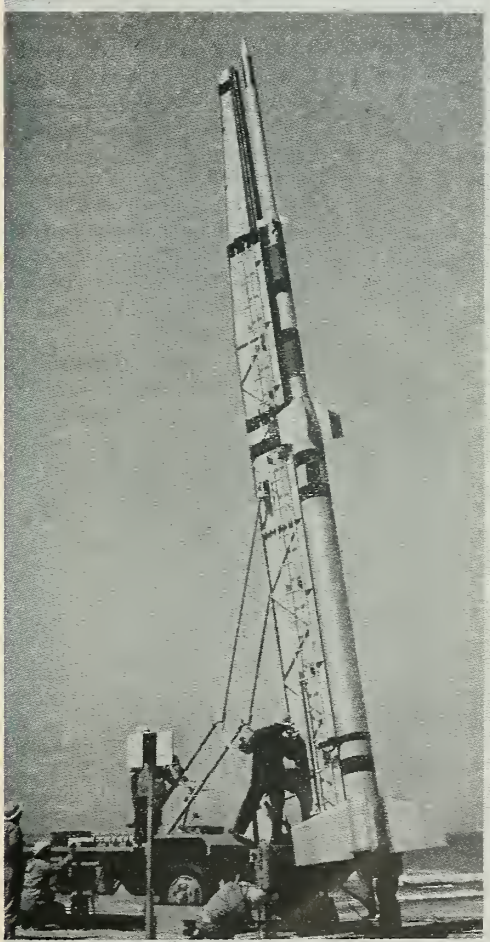
Australia is joining Britain in development of the new 40 ft. *Jaguar*. Royal Aircraft Establishment, Farnborough will build the first stage and Australia's Department of Supply will produce the second and third stages.

Deutsche Raketengesellshaft of Bremen fired mail carrying rockets and in June, West Germany's first off-the-shelf research rocket was unveiled at the Paris Air Show as an added attraction to Bolkow's *Cobra* antitank missile.

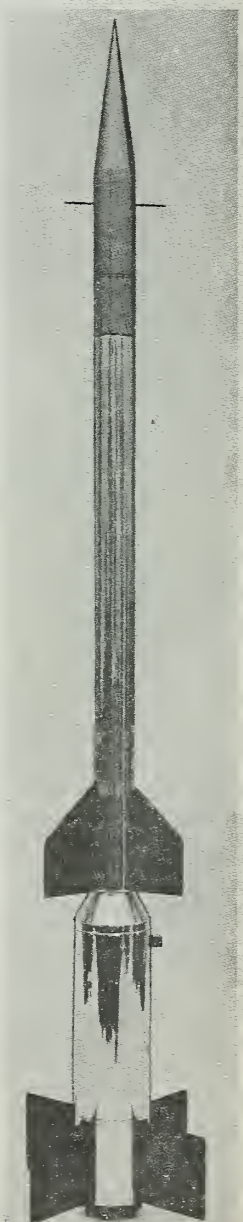
• **French research**—France's D.E.F.A. *Véronique* may soon be replaced by new vehicles produced by French industry. Sud Aviation's two-stage, solid *Centaure* with C.N.E.T. instrumentation carried 70 lbs. to 85 miles altitude in a series of recent tests and newer Sud *Dragon* and *Pegase* rockets will



CENTAURE: Closeup of Sud's rocket equipped with special booster and Ram second stage.



KAPPA 9: Fired for first time on April 1, reached 250 miles over Japan's Akita Range.



AEOLUS: Australian research rocket will carry 30 lbs. up to 240,000 ft. altitude.

Nations Developing Rocket or Space Systems

Country	Military	Scientific	Space Systems	Space Support
1. ARGENTINA	X*	X*		
2. AUSTRALIA	X*	X*		X
3. CANADA		X*	X	
4. FRANCE	X*	X*	X	X
5. INDIA	X	X		
6. IRAQ	X*			
7. ISRAEL	X	X		
8. ITALY	X*	X		
9. JAPAN	X	X*	X	X
10. NORWAY	X*			
11. POLAND		X*		
12. RED CHINA	X	X		
13. SPAIN	X	X		
14. SWEDEN	X*	X		
15. SWITZERLAND	X*			
16. UNITED ARAB REP.	X	X		
17. UNITED KINGDOM	X*	X*	X	X
18. U.S.A.	X*	X*	X*	X*
19. U.S.S.R.	X*	X*	X*	X*
20 WEST GERMANY	X*	X		
21. YUGOSLAVIA	X	X		

Note: *—Operational System(s)

Nations Participating in NATO Missile Production Only

22. BELGIUM
23. DENMARK
24. GREECE
25. NETHERLANDS
26. TURKEY
27. PORTUGAL
28. NEW ZEALAND—hos several missile destroyers under construction but the missile systems are British. (SEATO)

carry identical payloads to 250 miles and 600 miles respectively.

A 1760 lb. solid "Stromboli" propellant booster destined for *Dragon* and *Pegase* was also recently proven at Hammaguir. In June an experimental *Agathe* with a 4000 lb. *Mammouth I* solid stage lifted 1500 lbs. of test equipment to 160,000 feet. The payload was recovered by parachute over the desert. *Mammouth III* will have a standard 265 lb. instrumented payload for the deepest probes yet scheduled in Europe—1000 miles.

Another newcomer is *Bérénice*, an improved *Antarès* by O.N.E.R.A. It has two versions, the III and the IV—for number of stages. *Bérénice IV* has been described by Maurice Roy, O.N.E.R.A. Director, as capable of carrying a 132 lb. capsule to 600 miles altitude.

Military applications are suggested for the four stage *Bérénice* as was the case for the *Antarès*. Multichannel data on its Mach 12 reentry performance will be valuable for France's IRBM program directed by the national S.E.R.E.B. agency. *Bérénice* will be the first long range rocket with "some form of internal guidance" in the first and perhaps the second stages, say Paris sources. These tests may herald inertial guidance for French military missiles.

Italy also has an IRBM program study under way for a 900 mile vehicle. The only announcement identified Ministero Difensa Aeronautica as program coordinator but it has been routine for SISPRE, Bombrini-Parodi Delfino and other leaders of Italian rocket development to be involved in all national programs.

These same firms are associated with Contraves Italiana, S.p.A. in developing research hardware for Italy's new space program directed by the Italian Committee on Space Research Council.

NASA's International Programs Division gave Italy a helping hand by inaugurating a probe program from Perdasdefuego Rocket Range on Sardinia using *Nike-Cajuns*. Some vehicles since then have included an Italian *C-7* as the third stage. The most recent Sardinia joint tests were concluded in July.

• **Minor efforts**—The most modest scientific programs are in Spain, Yugoslavia and India. Although sources in New Delhi insist the Air Force Ministry has several missile research projects the only announced launchings have been efforts by the India Astronautical Society which receives little national support. The best IAS effort has been a 5 lb. transmitter aboard a rocket which reached about 90 miles. A dozen receiving stations in southern India studied ballistic behavior. A new two stage rocket fueled by a plastic-derived propellant is next to be tested.

The Swiss army uses operational *Mosquito* antitank missiles. The main emphasis has been on Contraves/Oerlikon surface-to-air versions which attract overseas buyers. Systems are in Japan and Italy. For their own anti-aircraft use, the Swiss recently placed a multi-million dollar order for Bristol/Ferranti *Bloodhound II*'s.

In the southern hemisphere, New Zealand plans several missile destroyers but armament will be procured in Britain. The New Zealand Navy chose the Short Brothers ship-to-air *Seacat* as West Germany has done. Argentina is coordinating its naval propellant production with Air Force metallurgical programs apparently under a central Space study agency. Her own multi-stage research rockets along with imported American rockets have been launched this summer at Cordoba in the interior.

Australia has one of the largest overseas ground support stations as part of NASA's man-in-space program. Moreover officials at the Woomera range have admitted official discussion on the feasibility of satellite launchings from Australia.

Japan has appropriated funds to take part in a joint space project with NASA but no definite program has yet been announced. There is Japanese pressure building to increase the *Kappa* project to include a satellite carrier rocket within the next few years. ¤

Ablative Material

(Continued from page 26)

In sub-scale rocket motor tests, the materials have performed well. Both forms of phenolic resin have shown low erosion rate and thermal conductivity.

The amorphous materials are not ignited by open flame and have an emissivity of 0.9. Specific gravity is 1.3 to 1.5.

Sterry said the HITCO-C series is designed to combat the major problem of spalling and other detrimental erosive effects.

Reinforced plastics now being used in rocket vehicles as nose cones, blast tubes and exit cones are selected on the basis of characteristics fitting them for specific applications—one of the most popular being graphite fiber phenolic-resin molding compounds.

• **Where most fail**—The resulting composite structures have high erosion resistance and high conductivity through the graphite phase, according to Sterry, and their conductivity contributes to spalling, thus reducing reliability in the component.

The high mean temperature resulting from conductivity induces high thermal expansion, which is resisted by the backup structure—usually a low-conductivity material. This restrained expansion creates high stresses that produce spalling—a condition in which chunks of material are ejected from the aeffcted surface of the component.

"In random fiber or chopped fabric compounds, another phenomenon can occur," said Sterry, "because the individual fibers conduct quite a bit of heat into the interior of the resin mass, which pyrolizes and evolves gases which build up pressure and eventually explode or spall off volumes of the surface material." ¤

contracts

NASA

$589,026—**Pratt & Whitney Aircraft Div., United Aircraft Corp.**, Middletown, Conn., for space radiator and condenser research facility.

$500,000—**Siegler Corp., Hallamore Div.**, Anaheim, Calif., for design and production of advanced communications systems for Goldstone space vehicle tracking system.

$300,000—**P&W Aircraft Div., United Aircraft Corp.**, E. Hartford, Conn., for design and development of 250-watt H_2-O_2 fuel-cell powerplant system for Lewis Research Center.

$122,075—**A&C Div., Consolidated Electrodynamics Corp.**, Columbus, Ohio, for mass spectrometer for Lewis Research Center.

MISCELLANEOUS

$180,000—**Cubic Corp.**, San Diego, from GE's Missile and Space Vehicle Dept., for production quantities of ultra-high-frequency rate beacon for Project *Advent*.

$58,000—**Chance Vought Corp., Astronautics Div.**, Dallas, for development of a small, self-manenvering pack for individual crewman to wear to assemble space stations in orbit.

NAVY

$4,450,000—**Avco's Electronics and Ordnance Div.**, Cincinnati, Ohio, for arming and fuzing development for the *Polaris* missile.

$1,816,000—**Raytheon Co.**, Lexington, Mass., for electronics portion of guidance systems for advanced *Polaris* missiles.

$334,765—**Aeronca Mfg. Corp.**, Middletown, Ohio, for 115 targets similar to *Pogo-Hi* (less rocket motor and rocket fins) and 215 sets of tail fins for use with same and *Beacon I* rocket motor.

$188,350 — **Minneapolis-Honeywell Regulator Co.**, Hopkins, Minn., for *Little John* rocket trainer, Phase II.

$97,683—**Tasker Instruments Corp.**, Van Nuys, Calif., for services, labor and materials to fabricate guided-missile launcher test sets.

AIR FORCE

$50,000,000—**Hercules Powder Co.**, Wilmington, Del., for research and development on *Minuteman* third-stage propulsion unit, and delivery of several flight-test motors for the rocket to Cape Canaveral.

$28,500,000—**Avco's Electronics and Ordnance Div.**, Cincinnati, Ohio, for production of FPS-26 height finder radar.

$1,500,000—**Radio Engineering Laboratories**, Long Island City, N.Y., for tropospheric scatter equipment.

$878,500—**Marquardt Corp.**, Ogden, Utah, for mobile ramjet test sets, 5 ea., required data and spare parts for *Bomarc* missiles.

$800,000—**Beech Aircraft Corp.**, Boulder, Colo. Division, for two types of semi-trailers capable of transporting the fuel and oxidizer for the *Titan II* ICBM program.

$700,000—**Radiation, Inc.**, Melbourne, Fla., from **The Boeing Co.**, for *Minuteman* ground telemetry equipment.

$406,602—**Bechtel Corp.**, San Francisco, for research and theoretical studies of alternative general configuration of a large vacuum chamber and ancillary equipment.

$386,000—**RCA Service Co.**, division of **RCA**, Camden, N.J., for research studies and development of prototype solar simulator.

$250,000—**Atlantic Research Corp.**, Alexandria, Va., from Edwards AFB Flight Test Center, for work in field of multi-component fuels for rockets and ramjets.

ARMY

$70,685,283—**The Martin Co.**, Orlando, Fla., for completion of the test program, advanced phase; and production of *Pershing* weapon. (Two contracts.)

$11,005,269—**The Martin Co.**, Orlando, Fla., for *Pershing* weapon system. (9 contracts).

$6,327,886—**Convair/General Dynamics Corp.**, Pomona, Calif., for development of *Mauler* guided missile system. (3 contracts).

$6,258,314—**Sperry Rand Corp.**, Salt Lake City Utah, for furnishing and delivering repair parts for *Sergeant* guided missile system.

$4,746,525—**Philco Corp.**, Washington, Pa., for services and materials to engineer, furnish, install and test a complete operational communication system.

$3,957,124—**Nortronics Div., Northrop Corp.**, Anaheim, Calif., for *Hawk* launchers.

$2,999,986—**Nortronics Div., Northrop Corp.**, Hawthorne, Calif., for arming decision device.

$2,803,946—**Sperry Rand Corp.**, Salt Lake City, Utah, for research and development on *Sergeant* missile system.

$2,174,907—**Western Electric Co.**, New York City, for procurement of *Nike* replenishment spare parts. (6 contracts).

$2,120,365—**Missile Products Div., Freuhauf Trailer Co.**, Los Angeles, for basic enclosure and traller frame assembly.

$1,819,150—**Sperry Rand Corp.**, Salt Lake City, for arming decision device.

$1,621,274—**AiResearch Mfg. Co. of Arizona**, Phoenix, for engine for *Sergeant* missile system.

$1,211,453—**Aerojet General Corp.**, Covina, Calif., for instrumentation and installation for missile system and solid propellants.

$1,076,826—**Alpha Corp.**, Richardson, Tex., for installation of a high-frequency radio communications system. (2 contracts).

$992,356—**Hughes Aircraft Corp.**, Fullerton, Calif., for radar tracking stations and services and materials to integrate with modified AN/TSQ-38.

$889,145—**Radioplane Div.**, Northrop Corp., Van Nuys, Calif., for repair parts for target missile. (2 contracts).

$759,786—**The Martin Co.**, Orlando, Fla., for procurement of replenishment spare parts and concurrent repair parts and modification kits for *Lacrosse* missile system. (5 contracts).

$743,764—**Fairchild Camera & Instrument Co.**, Syosset, L.I., N.Y., for delivery and integration of PTS with *SD-2* drone systems.

$721,009—**The Hayes Corp.**, Birmingham, Ala., for *Pershing* missile trainers.

$720,000—**Fairchild Aircraft & Missiles Div.**, Hagerstown, Md., for long-range drone surveillance system.

$600,000—**Bendix Systems Div., Bendix Corp.**, Ann Arbor, Mich., for ground-based electronic equipment for Project *Advent* shipboard terminal.

$600,000—**Equipment Div., Raytheon Co.**, Norwood, Mass., for modification of pulse code modulation system.

$388,721—**Sperry Rand Corp.**, Salt Lake City, Utah, for telemetering equipment.

$371,602—**Convair/General Dynamics Corp.**, Pomona, Calif., for research and development of *Redeye* system.

$315,850—**Packard Bell Compnter Corp.**, Los Angeles, for design, fabrication and installation of high analog-to-digital system.

$281,139—**Sperry Rand Corp.**, Salt Lake City, for engineering services on *Sergeant* missile system.

$279,258—**Sperry Rand Corp.**, Salt Lake City, for *Sergeant* ground-handling and test equipment. (3 contracts).

$264,330—**Sonthern Associated Engineers, Inc.**, Huntsville, Ala, for technical reports related to various missile systems.

$185,000—**Datatrol Corp.**, Silver Spring, Md., for systems analysis and programming services.

$144,390—**Donglas Aircraft Co.**, Santa Monica, Calif., for *Nike-Hercules* launching equipment.

$139,965—**Sperry Rand Corp.**, Salt Lake City, for instructors on *Sergeant* missile system.

$99,429—**Aerojet-General Corp.**, Downey, Calif., for warheads for modification of *Nike-Hercules* missile.

REQUESTS

National Aeronautics and Space Administration, Langley Research Center, Langley Air Force Base, Va.

Design, Development and Fabrication of Heat Shield Assemblies Including Payload Fairings Despin and Separator Mechanisms for Solar Internal Power Project.

The NASA Procurement Office, Langley Research Center, has issued a request for proposal numbered L-1760 to acquire delivery of the above-noted heat shield assemblies in a quantity of 3 for use in testing certain payloads during weightless flight in space using multi-stage booster rocket vehicles.

Proposals are due to be received at the NASA Procurement Office, Langley Research Center, Langley Air Force Base, Va., by 4:30 p.m., August 25, 1961.

The following firms have been invited to participate: Fairchild Aircraft and Missile Div., Hagerstown 10, Md., Attn: Stanford Chester—Douglas Aircraft Co., Inc., 3000 Ocean Park Blvd., Santa Monica, Calif.—Atlantic Research Corp., Space Vehicles Group, Pasadena, Calif.—Texas Instruments, Inc., 6000 Lemmon Ave., Dallas 9, Tex.—Chance Vought Corp., Vought Astronautics Div., P. O. Box 5907, Dallas 22, Tex.—Grumman Aircraft Engineering Corp., Bethpage, L. I., N. Y.—Douglas Aircraft Co., Inc., 2000 W. Memorial Dr., Tulsa, Okla, Attn: L. C. Raburn—Thiokol Chemical Corp., Hunter-Bristol Div., Bristol, Pa.—North American Aviation, Inc., Space and Information Systems Div., Downey, Calif.—Bell Aerosystems Corp., Buffalo 5, N.Y.—Republic Aviation Corp., Missile Systems Div., Mineola, L. I., N. Y.—Hughes Aircraft Corp., Culver City, Calif.—Cubic Corp., 5575 Kearney Villa Rd., San Diego 11, Calif.—Systems Laboratories Corp., 14852 Ventura Blvd., Sherman Oaks, Calif.—Advance Industries, Inc., 640 Memorial Drive, Cambridge, Mass.—Systems Corp. of America, 1007 Broxton Ave., Los Angeles 24, Calif.—H. Koch & Sons, Inc., P. O. Box 127, Corte Madera, Calif.

NASA suggests that small business firms or others interested in subcontracting opportunities make direct contact with the above firms.

National Aeronautics and Space Administration, Langley Air Force Base, Va.

Design Fabrication Strain Gaging Proof calibrating strain gage-type force measuring balance.

The NASA Procurement Office, Langley Research Center, has issued a request for proposal numbered L-1730 to acquire delivery of above-noted strain gage balances in quantities of 5 or 7 for use in Research and development work at Langley Air Force Base, Va. These strain gage balances will be used in small hypersonic high stagnation temperature tunnels.

Proposals are due to be received at the NASA Procurement Office, Langley Research Center, Langley Air Force Base, Va., by 4:30 p.m., August 14, 1961.

The following firms have been invited to participate:

Allegany Instrument Co., 1091 Wills Mountain, Cumberland, Md., Attn: G. William Harrison, Gen. Mgr.—Chance Vought Corp., Vought Astronautics Div., P. O. Box 5907, Dallas 22, Tex.—Convair Div. of General Dynamics, Ft. Worth, Tex., Attn: J. H. Schlicher, Dept. 6—Grumman Aircraft Engineering Corp., Bethpage, L.I., N.Y., Attn: Saul Ferdman—Lockheed Aircraft Corp., Burbank, Calif., Attn: B. D. O'Laughlin—North American Aviation, Inc., Los Angeles Div., International Airport, Los Angeles, Attn: R. P. Davie, Group Leader, Aero-Thermo Models—Task Corp., 1009 E. Vermont Ave., Anaheim, Calif.—Lesslells and Associates, Inc., 916 Commonwealth Ave., Boston 15, Mass., Attn: R. F. Brodrick—Dynametrics Corp., Northwest Industrial Park, Burlington, Mass.

NASA suggests that small business firms or others interested in subcontracting opportunities make direct contact with the above firms.

missiles and rockets
4th Annual

ground support equipment issue

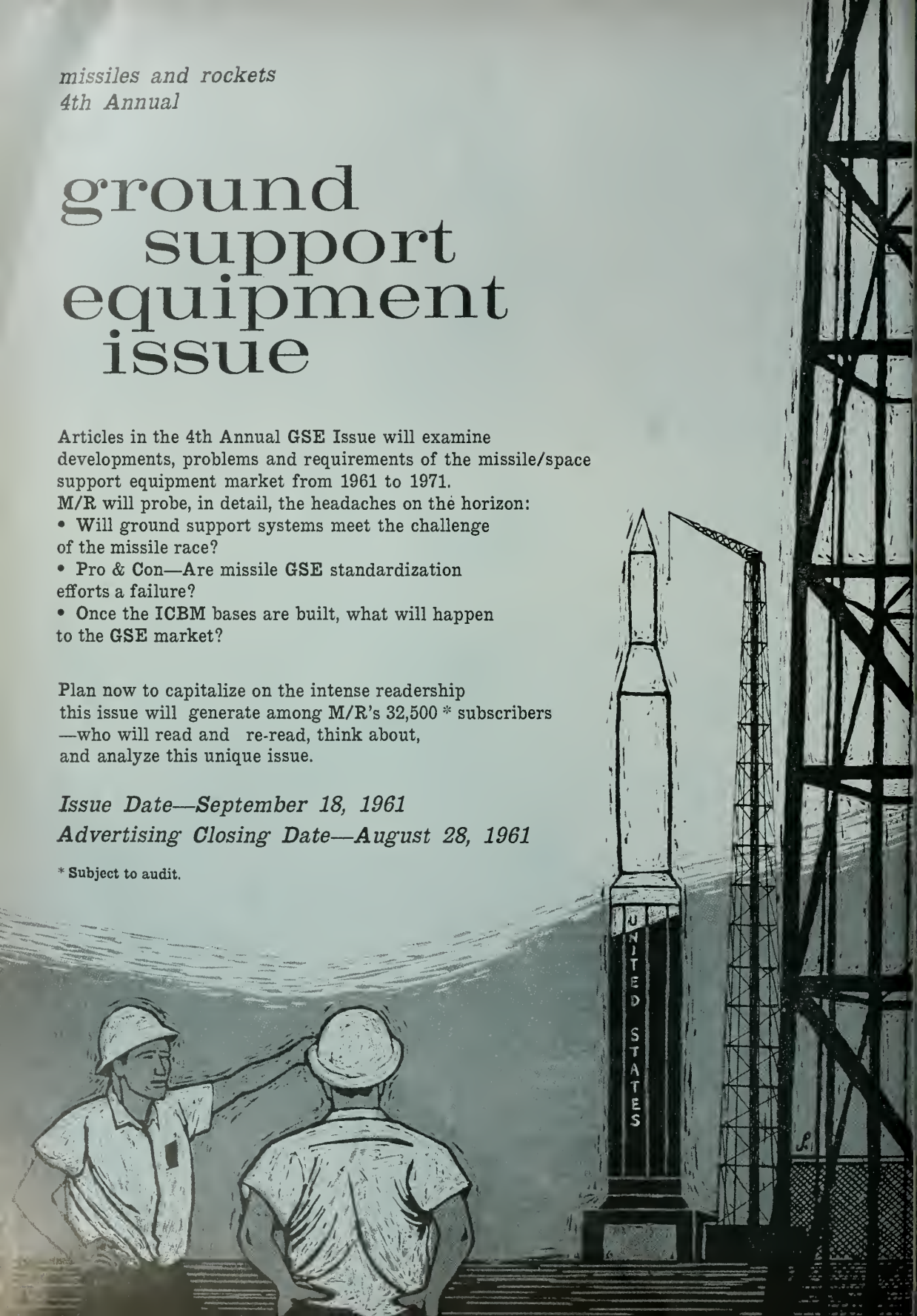
Articles in the 4th Annual **GSE** Issue will examine developments, problems and requirements of the missile/space support equipment market from 1961 to 1971.
M/R will probe, in detail, the headaches on the horizon:

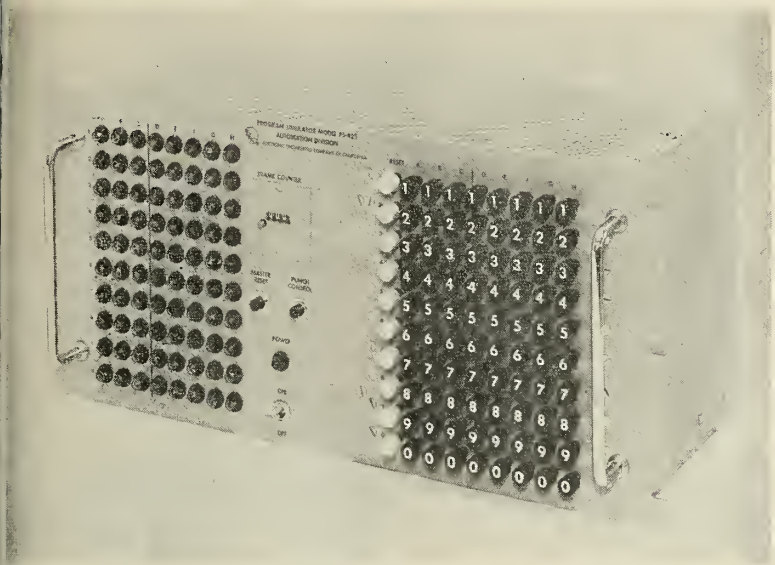
- Will ground support systems meet the challenge of the missile race?
- Pro & Con—Are missile **GSE** standardization efforts a failure?
- Once the **ICBM** bases are built, what will happen to the **GSE** market?

Plan now to capitalize on the intense readership this issue will generate among M/R's 32,500 * subscribers —who will read and re-read, think about, and analyze this unique issue.

Issue Date—September 18, 1961
Advertising Closing Date—August 28, 1961

* **Subject to audit.**





Manual/Automatic Program Simulator

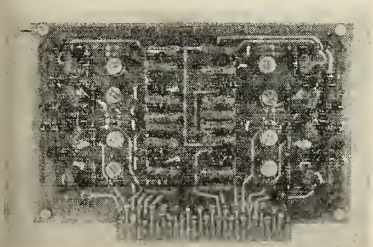
A program simulator which combines manual programing and automatic punch control is available from the Automation Division of the Electronic Engineering Co. The PS-425 Program Simulator is an integrated manual programer and automatic punch control for creation of automatic program tapes in automation equipment. Transfer of the test configuration automatically from the simulator to the punched tape is accomplished without the preparation of a punching chart.

The PS-425 may be substituted for a TP-400 series tape reader to allow manual setup and crosscheck of a desired test configuration prior to punching of a tape. The PS-425 will eliminate blind punching errors in complex programs. The program simulator is supplied in an 80-bit configuration, while the PS-426 is a 96-bit configuration and the PS-427 is a 120-bit model.

Circle No. 225 on Subscriber Service Card

Reversible Decade Counter

A reversible decade counter, capable of integrating both plus or minus pulses at rates up to 150 kc, may now be readily assembled by interconnecting two or more Model CM-105 binary-decimal reversible counter circuit modules available from Circuit Structures Lab. The Model CM-105 units, part of a series of digital building blocks supplied by CSL, each consist of a single printed-circuit card carrying a four-stage binary decimal counter and the necessary control circuits to perform both forward and backward counting operations. Each card also includes logic circuits that provide forward and reverse carry signals to adjacent counter cards.



Cicle No. 226 on Subscriber Service Card

Miniature Mixer Amplifier

Astronautics, Inc. has available a high-amplification, three-stage, feedback audio amplifier designed for guided missile, aircraft and similar application. Designated Model AGA-100-002, it meets all applicable military specifications and all of its components are accessible for visual inspection. Its output voltage is adjustable by an accessible potentiometer. A switch is available for grounding the amplifier's input, and two test points are provided for output and input voltage measurement. The company says the unit is not susceptible to the salt conditions of Atlantic or Pacific Missile Range operations.

Circle No. 227 on Subscriber Service Card

Recording Oscillograph

Minneapolis-Honeywell's Heiland division has introduced a direct-recording oscillograph with an optional built-in flash tube timer that produces full-width time lines on recording paper at any of three intervals. The Visicorder 906C employs a timing circuit that can be triggered externally by either supplying pulsing voltage of 10v at 20K ohms impedance, or by causing impedance to drop to 100 ohms or less through shorting-out or other means.

Circle No. 228 on Subscriber Service Card

Symbol Generator

A solid-state character generator has been developed by RMS Associates, Inc. It combines continuous straight and curved lines to form all digits, all letters and many symbols in a fully transistorized compact package. The Curviline can be used with any cathode ray tube display. High character writing rates for the full alphanumeric unit (to 50,000 characters per second, standard) are obtained by forming all symbols from simple formats. Curved lines prevent confusion between similar letters and digits such as the B and 8, the 5 and S and the D and O.



Circle No. 229 on Subscriber Service Card

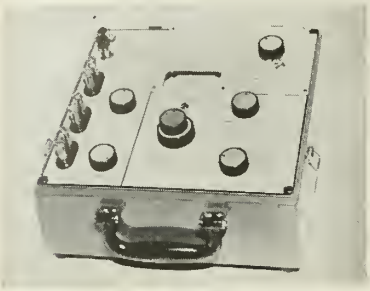
Dual Attenuator

A combination power attenuator and non-inductive resistance load bank is being introduced by Seco Electronics Inc. The Model 511A attenuator is of typical "T" pad design. Maximum power dissipation rating at the input connector is 50 watts. It is particularly useful where a power amplifier is being used to drive a second amplifier having lower power drive requirements.

Circle No. 230 on Subscriber Service Card

Strain Indicator

Metrix, Inc. is marketing portable transistorized strain indicators. The Model PS7-LT operates from self-contained batteries or external a-c supply, and offers features found in no other



single instrument used for strain measurement. Using integral controls it is possible to balance the measurement bridge, after which strain is read directly from the instrument. Multi-point and long-term strain measurements are also possible.

Circle No. 231 on Subscriber Service Card

Microwave Oscillator

The Instrument Division of Laboratory for Electronics, Inc. is marketing an ultra-stable microwave oscillator, model 814-L-9, for applications in missile and satellite telemetry. The instrument is designed to exceed requirements recently established by the Range Commanders' Conference on Telemetry Standards (Document No. 106-60) which call for frequency stability in the 2200 to 2300 mc telemetry band of 0.005% for transmitters and 0.001% for receivers. The 814-L-9 brackets the telemetry band with a tunable frequency range of 2000 to 2500 mc/s, and has a short-term stability of five parts in 10^8 and long-term stability of one part in 10^6. The dial is calibrated in one mc/s divisions with an accuracy of 0.1% absolute.

Circle No. 232 on Subscriber Service Card

Missile Battery

The Missile Battery Division of the Electric Storage Battery Co. is marketing a low-weight, small-size silver-zinc primary battery for missile application. The 24-volt Model 79 battery automatically activates within one second and has a discharge time of 0.83 minute, when discharged at 10 amperes. It has a capacity of 0.14 ampere-hour and delivers 3.06 watt-hrs./lb. and 0.19 watt-hr. per cu. in. The primary battery performs reliably at altitudes up to 50,000 ft. within the temperature range of −65° to 160°F at any position of the missile.



Circle No. 233 on Subscriber Service Card

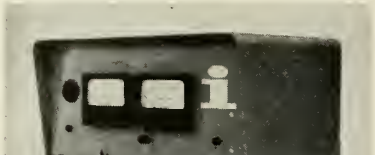
Hydraulic Servo Systems

Hydraulic servo actuator systems developed by Vickers, Inc., Division of Sperry Rand Corp. represent a new concept in tuning microwave tube oscillators. A complete system, including a linear servo actuator, hydraulic power supply and electronic controls, can tune a microwave tube through its frequency range at a constant or variable sweep rate. It is capable of following rapidly and accurately any wave, ramp or step input within its response characteristics. Control power requirements are minimal; the Vickers servo valve requires control power of 0.1 watt.

Circle No. 234 on Subscriber Service Card

Vacuum Gauge Control

Ilikon Corp. is marketing an ultra-high vacuum gauge control which combines an extended pressure range with automatic emission current control. Model 1020 can be used with any commercially available ultrahigh vacuum gauge to provide linear, stable measurement readings throughout the pressure range of 10^{-3} to 10^{-12} mm. hg. In addition, the emission current can be



pre-set and automatically controlled throughout long-term pressure readings. The emission current is variable from 0 ma to 10 ma, and stable to within 2%.

Circle No. 235 on Subscriber Service Card

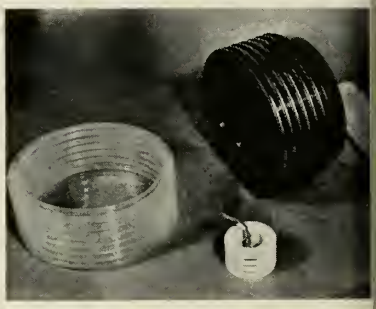
Surge Suppressor

Overvoltage protection for silicon and germanium cells, controlled rectifier cells, and similar devices is provided by a surge suppressor, called Voltrap, available from the Westinghouse Electric Corp. Because of its Zener-type volt-ampere characteristic, the protective device provides a shunt path for transient overvoltages and imposes a ceiling above which the surge voltage cannot rise. This permits the use of silicon cells without subjecting them to overvoltage, providing the cells have a peak-voltage rating above the clamping voltage of the surge suppressor. The Voltrap surge suppressors include polarized and nonpolarized units, multiple assemblies of polarized and nonpolarized units, and special non-standard units, and have rating ranges of 2 to 85 amperes maximum discharge current and 30 to 480 a-c rms volts.

Circle No. 236 on Subscriber Service Card

Telflon Slip Rings

A line of teflon slip ring assemblies available from Electro-Tec Corp. are capable of handling very high voltages without characteristic arcing damage even under operating conditions of ex-



treme humidity. At the same time they maintain very high resistance between circuits and offer extreme inertness throughout temperature range of −200°C to 200°C.

Circle No. 237 on Subscriber Service Card

High-Pressure Microfilter

Fluid Dynamics Inc. is producing a "T"-type high-pressure microfilter with greatly increased capacity and much lower pressure drop than standard designs. In average-sized units, rated capacity is boosted as much as 25%. In large units the gain is even greater. Units operate at pressures up to 10,000 psi. They remove particles ranging in size as desired from 100 down to 2 microns. The offset of the outlet port has the further advantage of prolonging element life. It allows the top flange of the element to be designed as a conical "splash" plate. This feature dispenses the fluid more evenly around the element and prevents local overloading.

Circle No. 238 on Subscriber Service Card

Microminiature Connectors

Omega Precision, Inc. is marketing a line of microminiature multi-pin connectors featuring a unique key pin arrangement which eliminates mismating of contacts. Incorporating resilient inserts and potted back ends, units are highly resistant to vibration, shock and

moisture. Contacts are crimped onto wires, and inserted into connector bodies after crimping—a construction which meets applicable test requirements of MIL-C-26636. To provide positive holding power, units employ Omega "Tran-Grip" sockets, which are widely used in solderless mounting of components to printed circuit boards.

Circle No. 239 on Subscriber Service Card

Digital Logic Modules

The Data Systems Division of Harman-Kardon, Inc. has announced the availability for stock delivery of the Series 200 Encapsulated Digital Logic Modules. The modules are rated for operation over the frequency range d-c to 250 kc, and all units are designed by the "worst-case" design technique for operation over the MIL-E-5272 D temperature range (−54°C to +71°C). Constructed by the "bundle board" construction technique, each module is epoxy-encapsulated in a color-coded epoxy shell, of standard modular dimensions.

Circle No. 240 on Subscriber Service Card

36-Unit Switch Panel

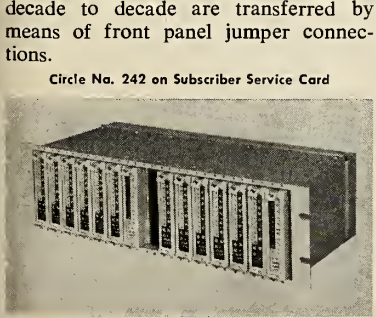
A compact switching panel with 36 miniature, interlocking switches is available from Pepco, Inc. Switches are set in 3 rows of 12 with a barrier between each push-button. The panel also holds a master release button that must be depressed before any of the other 36 keys are depressed. All interlocking is mechanical, to provide maximum reliability. The interlocking action may be varied to provide positive or momentary locking for individual rows or groups.

Circle No. 241 on Subscriber Service Card

Pulse Counting Systems

A dual-channel, 10 megacycle pulse counting system is available from Harvey-Wells Electronics, Inc., as a standard product. The HW system consists of two separate 7-decade, 10-megacycle pulse counting units in a standard HW data-bloc module bay. Each channel consists of a single 10-megacycle HW decade scaler followed by six one-megacycle HW scalers. Carry pulses from decade to decade are transferred by means of front panel jumper connections.

Circle No. 242 on Subscriber Service Card



Photoelectric Reader

Melpar, Inc. is marketing a highly sensitive, miniaturized photoelectric reader. The Model 150 Reader, combining a light source, lens and photocell in a single unit, was designed for use in automatic control systems using electronic circuits which operate as a function of reflected light. At a distance of ⅛ in. from the lens a resistance range of approximately 25,000 to 250,000 ohms is available, with light reflection from white to black surfaces.

Circle No. 243 on Subscriber Service Card

Rotary Solenoids

A solenoid originally designed to operate rotary switches in high-power circuits used in missile and rocket applications is now being applied to the specific requirements of military and commercial manufacturers by Singer-Bridgeport, a division of The Singer Manufacturing Co. The solenoid action, being a pure rotation of a balanced rotor, requires no linkages to convert linear motion to rotary and, therefore, is inherently resistant to mechanical environments such as axial vibration and shock.

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new literature

BUWEPS GUIDE—Designed as a compact, authoritative aid to all sales and engineering representatives, a pocket guide to BuWeps has been published by Defense Information, Inc. Featured are comprehensive explanations of the entire BuWeps organization, basic responsibilities of subdivisions, budget and funding information broken down from primary appropriations areas to the programed funding in codes and a complete list of personnel with locations.

Circle No. 200 on Subscriber Service Card

POWER PACKS—Electronic Research Associates, Inc. has published a two-page bulletin containing detailed mechanical data on their complete line of Transpac miniaturized power packs. Included is case-size data, tolerances, terminal connections, mounting information, and related data. Drawings covering case sizes and terminal orientation are included.

Circle No. 201 on Subscriber Service Card

PRECISION WELDING—A generation of precision resistance-welding power supplies featuring solid-state design, dual watt-second ranges and optional voltage regulation, and based on the asymptotic charging principle, is described in a catalog available from Weldmatic Division/Unitek. Power-matched welding heads range from ultrasensitive units for interconnecting component leads in assembly of miniature electronic circuit modules to heavier-duty, more versatile models used in a wide variety of metal joining applications including the joining of lead wires to potentiometers, relays, and circuit headers.

Circle No. 202 on Subscriber Service Card

FLEXIBLE COAXIAL CABLE—Andrew Corp. has published a comprehensive 16-page catalog on Neliax, the flexible airdielectric cable. The cable, introduced in 1952 by Andrew, has found universal acceptance in the RF field. The catalog describes in detail the improved electrical and mechanical characteristics of Heliax and accessories now available in 50, 75 and 100 ohms and in a range of sizes from ⅜ to 3⅛ inch.

Circle No. 203 on Subscriber Service Card

COMPUTER SIMULATOR—Technical Bulletin 60-F describes Model 2032 Memory System Exerciser, an automatic high-speed digital computer simulator that tests and evaluates complete memory systems over a wide range of operating parameters, is available from Rese Engineering, Inc. The bulletin emphasizes the machine's capability of simulating an exact computer environment for testing coincident-current and word-organized core, twister, rod, multi-aperatured and thin-film memories during development, prototype and production stages, and points out that address-to-address cycle times are continuously variable from three to 100-microseconds.

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CAPSCREW—A high-strength, stainless-steel, socket head capscrew family is reviewed in a four-page technical bulletin from Standard Pressed Steel Co. It gives both specification and performance data for the Unbrako KS 812, rated at an increased tensile strength of 125,000 psi minimum at room temperature, and for a wide temperature range of application from −300° to 800°F. A table of typical mechanical properties gives tensile, yield and shear strength, fatigue endurance and stress relaxation values for various temperatures.

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DISCRIMINATORS — An eight-page brochure describing phase-locked-loop discriminators for telemetry ground instrumentation is available from Electro-Mechanical Research, Inc. The brochure features a discussion of the phase-locked-loop characteristics and advantages in FM demonstration and describes and gives specifications of the EMR Models 167 transistorized and 165 vacuum tube phase-locked-loop discriminators.

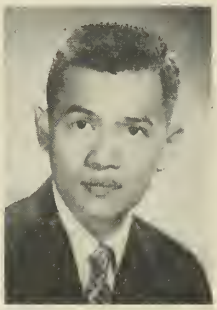
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names in the news


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William F. Rueger: Named vice president and general counsel of Sylvania Electric Products, Inc., a subsidiary of GT&E Corp. He will also continue as secretary of the company.

Brig. Gen. Harold K. Kelley: Assigned as Assistant Deputy for Site Activation of Ballistic Systems Division, Air Force Systems Command, Los Angeles. Gen. Kelley formerly served in Washington, D.C. as Deputy for Construction, Directorate of Civil Engineering, Headquarters, USAF.

John K. Records: Appointed manager of newly-formed Instrumentation and Guidance Product Section in General Electric Co.'s Defense Systems Department, Syracuse, N.Y. Records joined the department when it was organized in 1958, as manager of the Military Systems Section.

George E. Chutka: Promoted to manager of Missile Industry Liaison, Minnesota Mining & Manufacturing Co., St. Paul.

W. C. Hobbs: Elected vice president of North American Aviation, Inc., Los Angeles. With NAA since 1943, he worked in labor relations, plant engineering and administrative positions before becoming assistant to the senior vice president-administration in 1956. He will continue in the latter position.

Dr. Maurice Goldhaber: Outstanding authority in nuclear and fundamental particle physics, appointed director of Brookhaven National Laboratory, L.I., N.Y. Dr. Goldhaber succeeds **Dr. L. J. Haworth,** who was appointed a member of the U.S. Atomic Energy Commission on April 15. In the interim, **Dr. G. F. Tape** has served as acting director; he will continue as deputy director under Dr. Goldhaber.

Dr. Ernest G. Brock: Appointed manager of Quantum Physics Laboratory, General Dynamics/Electronics' Research Division. Other appointments to the Research Division are: **Dr. Carl E. Drumheller,** manager of Physical Electronics Laboratory; **Dr. Gerald W. Sears,** manager of Molecular Physics Laboratory; **Dr. Hisao Yamada,** manager of Information Processes Laboratory.

Keith B. Banks: Former deputy chief of Air Defense Operations Division, office of Deputy Chief of Staff for Operations, Department of the Army, appointed programs department manager, Space Recovery Systems, Inc., El Segundo, Calif.

Col. Kirk R. Buchak, USA (ret.): Assumes management responsibilities for construction and installation of communications systems with Page Communications Engineers, Inc., Washington, D.C. Until his retirement from the Signal Corps, Buchak was Chief, Plant Engineering Division, for the Defense Communications Agency.

Gim H. Lee: Former production manager of tungsten and molybdenum, Wah Chang Corp., appointed vice president in charge of operations, Metallurgical International, Wallington, N.J.

William H. Long: Named manager of the Nuclear Materials and Propulsion Operation, General Electric's Flight Propulsion Laboratory, Cincinnati. Long formerly was manager of applications and contracts.

George M. Leitch: Former program manager of NASARR radar projects at North American Aviation's Autonetics Division, joins Aeronutronic Division, Ford Motor Co., as special assistant to general operations manager and acting manager of fabrication services of Electronics Operations.

Dr. Robert F. McAlevy, Ill.: Named consultant in field of solid propellant combustion at Malaker Laboratories, Inc., Mountainside, N.J. Dr. McAlevy previously was responsible for solid-propellant research projects at Princeton University's Aeronautical Engineering Dept.

Ole A. Sandven: Promoted to vice president and director of Physical Metallurgy Dept., Ilikon Corp., Natick, Mass. Before joining Ilikon, Sandven was a research metallurgist at Massachusetts Institute of Technology.

Alan D. Bailey: Joins Space Instrumentation Division, Technology Instrument Corp. of Acton, Acton, Mass., as senior electronic engineer. Earlier, Bailey was assistant professor in electronic research at Northeastern Univeristy.

Dr. Sidney K. Shear: Named director of research of Naval Warfare Analysis Group, the long-range studies division of the Operations Evaluation Group (OEG), Massachusetts Institute of Technology, effective Aug. 1. Dr. Shear replaces **Dr. Douglas L. Brooks,** who is taking leave for research at MIT's Earth Sciences Laboratory. Before joining OEG, Dr. Shear was a staff physicist with the Navy's Bureau of Ships and Bureau of Ordnance.

Maj. Gen. John A. Barclay, USA (ret.): Joins The Lionel Corp., Hillside, N.J., as vice president for research and development. Gen. Barclay recently retired as Deputy Commander, Ordnance Missile Command, Redstone Arsenal, Ala.

Alonzo B. Kight: With Borg-Warner since 1948, elected president of Borg-Warner International Corp., Chicago. **Charles W. Mason** appointed vice president and assistant to general manager; and **Frank J. Hoyne,** vice president-sales of Mechanics Universal Joint Division.

Stanley M. Smolensky: Appointed general manager of National Electronics Division, Washington, D.C. of Thiokol Chemical Corp. Formerly Smolensky was director of operations at Thiokol's Reaction Motors Division.

Dr. Samuel W. Levine: Appointed technical assistant to the president's office, Fairchild Camera and Instrument Corp., Syosset, N.Y. Dr. Levine will be succeeded by **Berthold Pollick** as director of engineering and research for the Defense Products Division.

Dr. Robert J. Wineman: Appointed director of the Boston Laboratory, Monsanto Research Corp., Everett, Mass. Dr. Wineman formerly was in the special projects department of the Research and Engineering Division.

Maj. Gen. John S. Guthrie: Former commanding general of the XIVth Army Corps., named a vice president of Motec Industries, Inc., Hopkins, Minn. Gen. Guthrie also will serve as director of the Molectronics, Motec Engineering and Mohawk Foundry & Forge Divisions.

Interconnection . . .

(Continued from page 36)

by the second diagram, the work of the interconnection engineers has markedly improved the battery cable system. Comparison of the initial cabling layout and the final production layout provides a vivid example of the improvements. The advantages of the improved system over the old one are:

—The complement of cable assemblies per system is decreased from 69 to 29.

— The number of cable assembly types is decreased from 12 to 2—with no degradation of operation.

—The weight of the system is decreased by approximately four tons.

—The direct cost per system is estimated to have been decreased by $20,000. The indirect cost (such as savings in spare cables, vehicles, storage space and manpower) is indeterminable for the quantity of systems to be produced.

—Operational flexibility is gained by having the minimum number of cables.

• **Prime contractors at fault**—During the Raytheon interconnection program, it was found that the cable and connector companies were very cooperative in attempts to improve their products.

Therefore, it would seem that most cabling problems are caused mainly by prime contractors who do not provide engineers to work with the cable and connector companies at the outset of the development program. These small companies need the guidance and overall system coordination that can only be provided by the prime.

However, it is not feasible to conduct a program of this nature for one engineering R&D model. The cable and connector companies cannot cooperate on small orders because of the high costs of manufacturing.

Under these circumstances, one adequate, low-cost possibility might be the "blown-jacket" type of construction, with a consequent possible degradation of field performance. Proper system design will minimize the changes required in the various units to incorporate quality cable assemblies when production contracts have been awarded. ⌗

Martin Receives Contracts For Pershing Production

THE MARTIN CO. has received two letter contracts totaling more than $70 million from the Army for continued development and production of the solid-fueled *Pershing* missile system. Detailed contracts are to be signed later.

Martin said one contract is for completion of *Pershing* test and development, which the company began in 1958. The other is for production of missiles for delivery to combat units. Production of the 100-300 mile missile is expected to begin as soon as a contract is signed, a spokesman for Martin said. ⌗

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America Still Wants to Know

ON SUNDAY, July 30, golfing enthusiasts viewing the PGA tournament on television missed little Jerry Barber's startling finish because the tourney was cut off the air to make way for the first of a new TV series entitled "All America Wants to Know."

Missiles or bombers? That was the question at issue and the star performer on the show was Gen. Curtis LeMay, U.S. Air Force Chief of Staff.

"Some people say manned bombers are obsolete!" read the newspaper ad in advance of the show. "Is this true? The experts in the panel shown above will get the facts by firing questions at General LeMay. Tune in! This nation's survival may depend on our current military strategy."

The panel consisted of these well-known critics of manned aircraft: Sen. Barry Goldwater, a general in the Air Force reserve; Marguerite Higgins, wife of an Air Force general; Mundy I. Peale, president of Republic Aviation; Robert Hotz, editor of *Aviation Week* magazine; Arthur Godfrey, longtime friend and hunting companion of Gen. LeMay.

The result, with one exception, was as expected. There was a dull non-controversial parroting of the Air Force position in favor of more manned aircraft. Whatever all America wanted to know about the bomber vs. missile question could just as well have been learned by a continued viewing of the PGA tournament.

The one startling moment in the show came in a vitriolic denunciation by Gen. LeMay and Sen. Goldwater of a *New York Times* article.

The conversation went like this:

In response to what seemed to be a planted question, Gen. LeMay denied the truth of the article, which said the Air Force was preparing a vigorous appeal to Congress to invest more heavily in manned aircraft in view of the Soviet air show.

Sen. Goldwater said that when he saw the article he "knew it was wrong" and made a personal check.

"This was irresponsible reporting of the best (sic) order . . ." the Arizona senator declared. "This is a figment of some man's imagination."

Gen. LeMay added: "I think that sums it up."

We frankly were astonished for we seemed to remember Gen. LeMay himself making just an appeal to Congress. Yet the statements by Gen. LeMay and Sen. Goldwater went unchallenged by the other members of the panel, including the very able Mr. Hotz, who certainly should have known better.

WE decided to do a little checking of our own. *The Times* article by Jack Raymond appeared in the city edition on July 13. On July 18, the Senate appropriations subcommittee was briefed on the Moscow air show and Gen. LeMay appeared before the committee. We carried his testimony in this magazine. However, we will quote what Mr. Hotz' magazine reported. *Aviation Week* said:

"Gen. LeMay flatly told the Senate appropriations subcommittee that more and better manned aircraft are needed now and in the foreseeable future. He asked for $448 million this year and $500 million in each of the 'three or four' subsequent years for the B-70, as well as $525 million this year for an additional wing of B-52s."

The magazine pointed out that Gen. LeMay had been called in to rebut earlier testimony by Deputy Defense Secretary Gilpatric that there is no immediate need for more money for manned aircraft.

What then was the irresponsible reporting of Mr. Raymond? We looked up the July 13 article in *The Times*. It said:

"The Air Force is preparing a vigorous appeal to Congress to invest more heavily in bombers and other manned aircraft in view of the impressive Soviet air show last Sunday.

"Qualified sources said Gen. Curtis E. LeMay, Chief of Staff of the Air Force, planned to urge greater outlays than the Administration had requested to develop the controversial B-70 supersonic high-altitude bomber.

"In addition, General LeMay was described as ready to appeal an Administration decision to cut off production of B-52 and B-58 bombers. . . ."

Pretty accurate figments! Who were the general and the Senator trying to mislead and why? Suspecting that the show might have been taped, we checked with CBS. The enormity of the crime then became even greater. The show had been taped on July 16 for release on July 30.

This then was the sequence of events: Mr. Raymond's article appeared on July 13. Gen. LeMay and Sen. Goldwater denounced it as irresponsible reporting on July 16. Gen. LeMay went before the Senate appropriations subcommittee just two days later, on July 18, and said exactly what Mr. Raymond said he was going to say.

Mr. Hotz can be excused for not challenging the remarks since, on July 16, Gen. LeMay had not yet made his appearance on the Hill. But why the heated denunciation of *The Times* article by the general and the senator?

Such duplicity is unnecessary. It only discredits the legitimate objectives of the Air Force. If more manned bombers are needed, we should have them. But through normal procedures, not through tactics such as these and not through dull propaganda exercises such as the loaded TV panel.

We think Gen. LeMay and Sen. Goldwater owe their viewing public an explanation. All America wants to know.

As the ad said, this nation's survival may depend on our current military strategy.

William J. Coughlin

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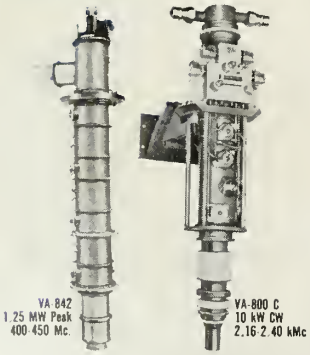
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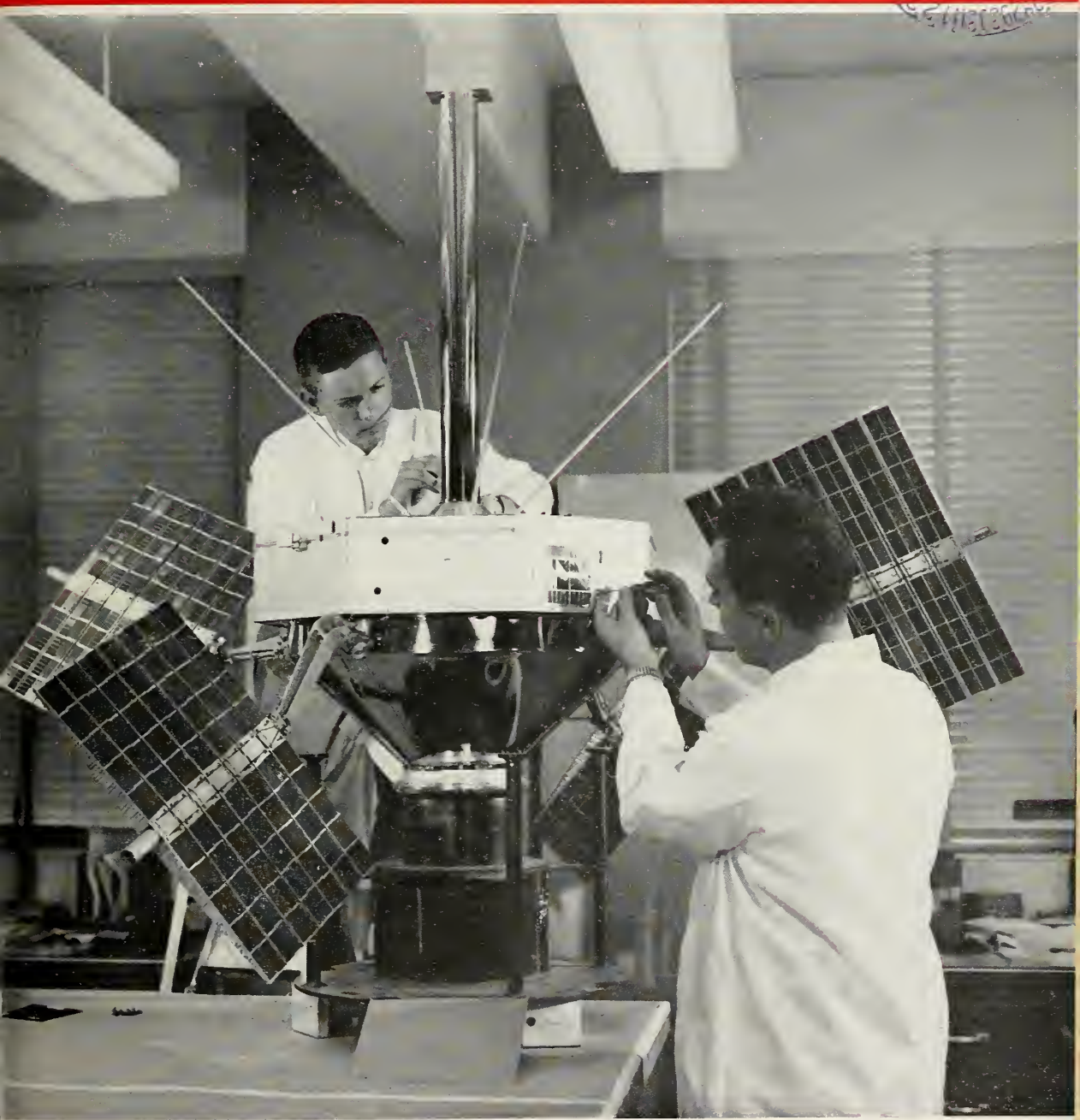
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AUGUST 14, 1961

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THE MISSILE/SPACE WEEKLY

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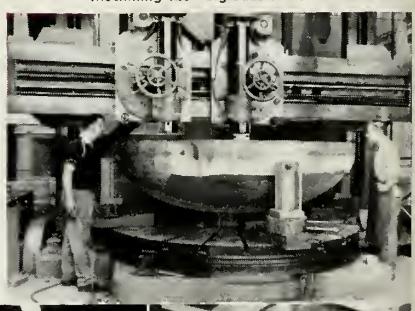


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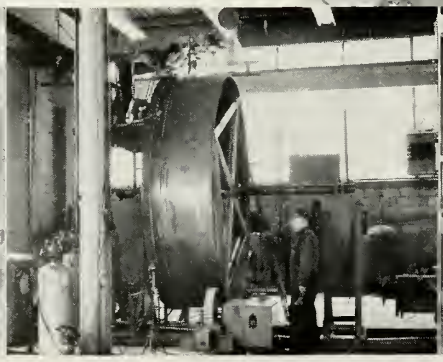
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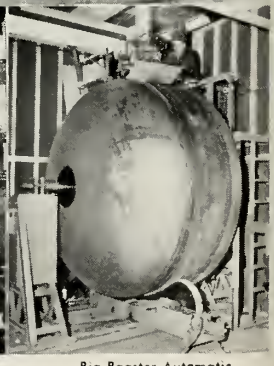




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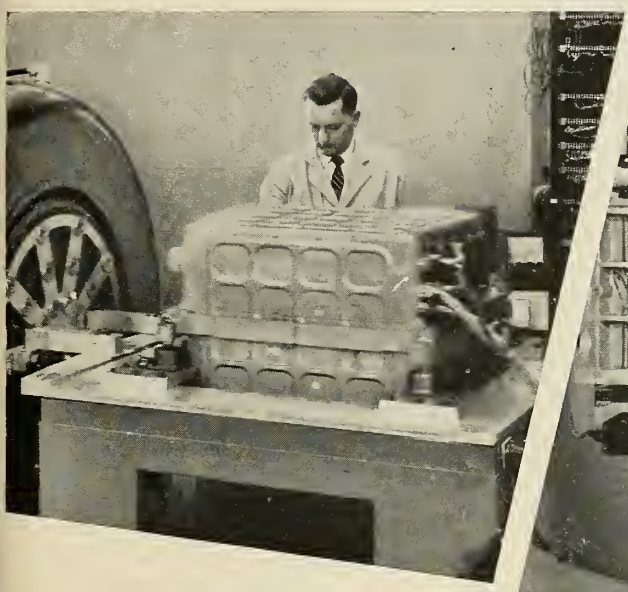
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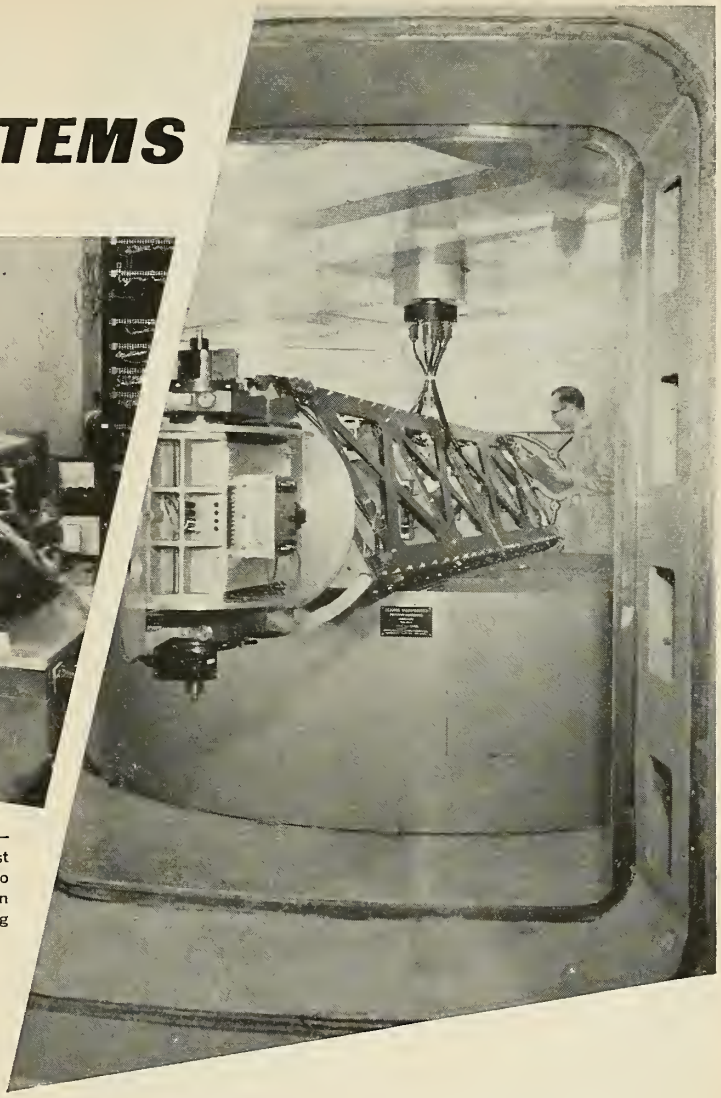
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THE MISSILE / SPACE WEEKLY

missiles and rockets

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John N. Carlin
Director of Circulation

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THE COVER

Technicians put finishing touches on NASA's S-3 satellite, scheduled for launch this week carrying experiments to investigate energetic space particles. See p. 16.



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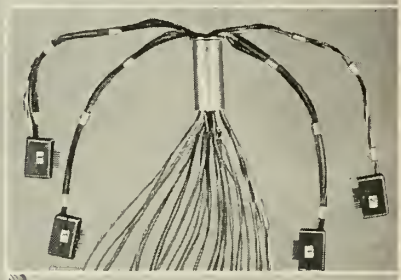
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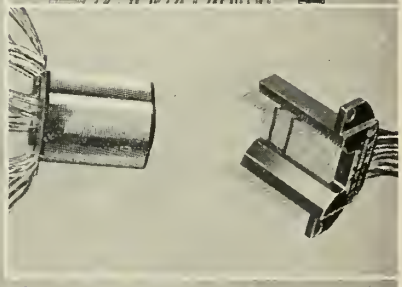
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letters

Good Fights and Works

To the Editor:

Your editorials are always good—no doubt because I think the way you do.

The one in your July 24 issue entitled 'Shuffleboard on the Moon" is outstanding. Keep up the good fight—you have thousands of people behind you.

E. S. Thompson
Defense Field Operations Dept.
General Electric Co.
Los Angeles

To the Editor:

Congratulations on your July 31 editorial ("The Great Tushino Stampede"), with which I wholeheartedly concur.

Articles such as yours may help to provide that needed ray of guidance out of the muddled, chaotic, "reactance" type of thinking which now appears to be extant in our executive, legislative, and military leadership.

Keep up the good work.

Jesse M. Townsley, Jr.
Sales Engineer
Aircraft and Missiles
Corning Glass Works
Corning, N. Y.

Training A-wasting

To the Editor:

As a regular reader of MISSILES AND ROCKETS, I wish to thank you for the clear way in which the articles about the many subjects that comprise the fascinating guided missiles are written. There is but one question—is it possible to include more about the many smaller guided weapons? I think that the many patents on missiles granted nowadays might give you a constant supply of interesting news.

Personally, I am also interested in the advertisements. Because I feel that there isn't too much outlook in my present job, I've written to some of the big missile firms in the U.S. Their replies, however, were all the same, referring to the difficult security measures that didn't allow them to employ a non-citizen.

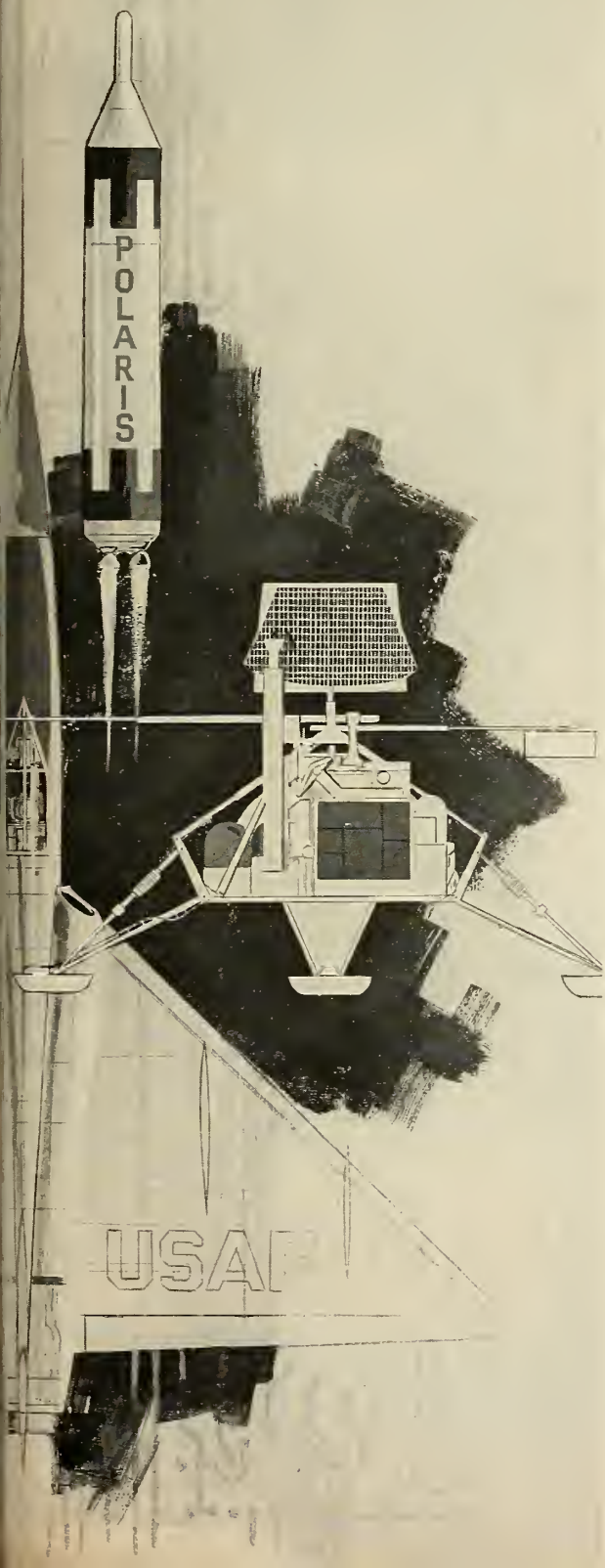
Especially after finishing a $4000 course on guided weapons in England last year, I regret to waste this knowledge; and because of the big investments in the missile industry in the U.S. I thought it wiser to try to get a job in your country...

As you can see in the enclosed personal notes, I have more than six years' experience in the ballistics of guns, and have specialized in the propulsion and control of guided missiles. Also, I can speak the following languages: Dutch, English, German, French and Malayan. Furthermore, I've some important people who can vouch for my capabilities and character.

(A Dutch reader)
Breda, the Netherlands

M/R will be happy to supply this gentleman's name, address and resumé to any firm or individual who may be interested.—Ed.

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Opportunities for

circuit designers

Requirements of new and continuing projects, such as Surveyor and supersonic interceptor fire control systems have created new openings for circuit designers. The engineers selected for these positions will be assigned to the following design tasks:

1 the development of high power airborne radar transmitters, the design of which involves use of the most advanced components,

2 the design of low noise radar receivers using parametric amplifiers, solid state masers and other advanced microwave components,

3 radar data processing circuit design, including range and speed trackers, crystal filter circuitry and a variety of display circuits,

4 high efficiency power supplies for airborne and space electronic systems,

5 telemetering and command circuits for space vehicles such as Surveyor and the Hughes Communication Satellite,

6 timing, control and display circuits for the Hughes COLIDAR* (Coherent Light Detection and Ranging).

In addition, openings exist for several experienced systems engineers capable of analysis and synthesis of systems involving the type of circuits and components described above.

If you are interested and believe that you can contribute, please airmail your resume to: **Mr. Robert A. Martin,** Supervisor, Scientific Employment, Hughes Aerospace Engineering Division, Culver City 73 California.

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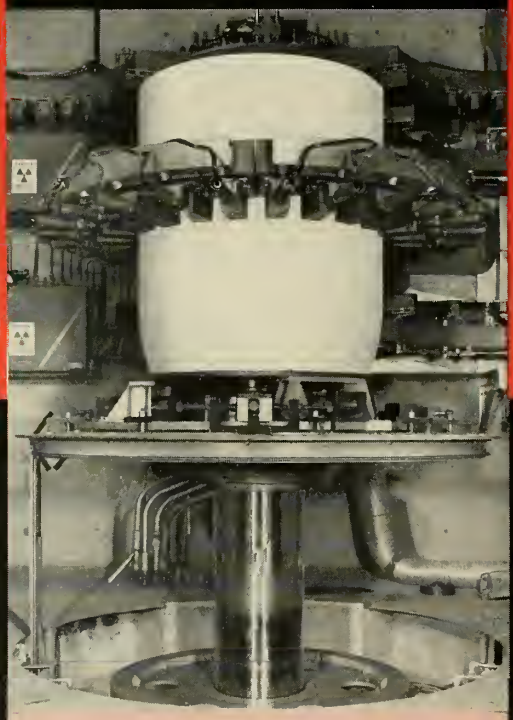
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The Countdown

WASHINGTON

Like Work, Maybe

Congress apparently is letting *Vostok II* pass without another investigation into how the U.S. space program can be speeded up. Everyone seems to know the answer by now—work. And, besides, Congress wants to go home.

Missilemanship on the Potomac

The Army and Air Force may yet come to some backyard fisticuffs over the forthcoming tests of *Nike-Zeus* against *Atlas* ICBM's. Certain elements in the Air Force are reported to be emphasizing that the *Atlas's* have been modified for the tests. The Army is complaining that the erroneous implication is the *Atlases* will be sitting ducks. Meantime, the first three-stage firing of a *Nike-Zeus* from Point Mugu, Calif., apparently has slipped into September.

Ethan Allen May Launch A2's in Fall

The nuclear-powered submarine Ethan Allen—first of the new 608 Class of *Polaris* subs—probably will test-launch 1500-mile A2 *Polarises* this fall. The Ethan Allen, which was commissioned last week, is scheduled to be deployed early next year. She is expected to carry 1200-mile-range A1 *Polarises* on her first war patrol and pick up operational A2's later in the year.

New NASA ComSat

NASA will announce shortly a new plan for building its own active communications satellite to "advance" technology in the field. This will be in addition to the *Relay* active ComSat being built for NASA by RCA and the four R&D satellites that NASA will launch for AT&T.

Big Booster Committee Working

A report is expected in about two months from a joint NASA-DOD committee studying present and future rocket booster needs. The committee will make a decision on the configurations for the *Saturn C-3* and the liquid and solid *Novas*. It also will develop hard recommendations on the size of future boosters, solid vs. liquid propellants, and the place of nuclear/electrical engines in the space vehicle picture.

INDUSTRY

Revolution Brewing with APT

More missile/space industry companies are awakening to the potentialities of automatically programed machine tools (APT). The Air Force and Aerospace Industries Association, sponsors of the project, claim APT could revolutionize the industry. The computer-fed system is designed for automated, extremely accurate small-lot production of highly complex parts at low cost and great savings in time.

Apollo Wind Tunnel

COUNTDOWN hears research into *Apollo* lunar spacecraft re-entry problems will be the main task for the $11-million wind tunnel which has just started operation at NASA's Ames Research Laboratory field, Moffett, Calif. The tunnel will operate at speeds of Mach 7:5, 10 and 15.

Basic Research Cost Jumps

Air Force figures show an 18% increase in basic research costs in the past year—mostly because universities have upped their prices. New price list items: A fully supported technical paper—$119,000; a math paper—$7600.

Research Intelligence

Avco is building three nose cones for NASA re-entry payloads—one to be flown aboard a *Scout* . . . Martin is winding up a NASA study which covers the problems of a lunar landing and immediate return for three astronauts; a 30-day stay for three men and also a permanent base for 10 to 12 men . . . The Space Science Board is urging NASA to train scientists as astronauts for moon flights . . . Air Force is increasing its chemistry research program by 50% this year.

Navy-Air Force Swap

The Air Force is taking over military representation at The Martin Co. from the Navy, and the Navy is replacing the Air Force at Sikorsky Aircraft.

Recruiting Pickup

Several major recruiting campaigns for engineers and scientists are under way in anticipation of a major beef-up in spaceflight programs. One of the biggest: 500 for Hughes Culver City aerospace labs.

INTERNATIONAL

Soviets Tracking Samos

Russian scientists at an international symposium in Pasadena, Calif., disclosed that the Soviets have used 400 visual trackers over the world to develop about 62,000 orbital plots—including 23,000 plots of U.S. satellites since Oct. 4, 1957. Among the plots were the trajectories of *Samos* and *Midas* vehicles.

Vulcan-Skybolt Modifications

Adapting *Skybolt* to British Vulcan bombers reportedly will include the addition of two underwing pylons and the installation of a pre-launch computer in the plane.

Overseas Pipeline

The German Rocket Society is launching a 10-ft., 132.5-lb., two-stage meteorological rocket to a 50-mile height next month at Cuxhaven . . . Sweden has just placed orders for SARAH (search, rescue and homing) equipment from Ultra Electric Ltd. of Britain . . . First model of the 100-ft., *Blue Streak*-based European satellite launcher will be displayed at Farnborough next month . . . West Germany's Army is establishing a permanent liaison office at the U.S. Army Ordnance Guided Missile School, Huntsville, Ala.

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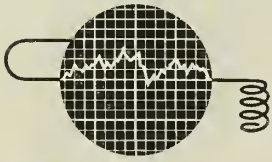
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The Missile/Space Week

DOD Ad Rule Set

House-Senate conferees agreed to a $46.6 billion FY '62 defense bill last week—including a greatly modified rider on defense advertising. The conferees accepted DOD-suggested exemptions that would permit three types of advertising to be charged to the government as allowable contract cost.

They are: recruitment of personnel required for performance of the contract, procurement of required scarce items, and disposal of scrap or surplus material acquired in performance of the contract.

Senate-added provisions for contractors to charge off the cost of advertising for subcontractors and participating in exhibits at the invitation of the government were dropped. The House version would have disallowed all advertising costs.

Shots of The Week

An Air Force *Atlas F* went 5000 miles down the Atlantic Missile Range Aug. 8 in the advanced model's first test firing. Designed to carry a nuclear warhead 6300 miles in 30 minutes, the "quick firing", 82.5-ft. missile was checked out for instrumentation and guidance.

A *Jupiter* IRBM was fired 1500 miles Aug. 5 by NATO troops, using tactical GSE. The Cape Canaveral shot was the missile's third checkout and firing with operational ground equipment.

Russia's Maj. Gherman Titov orbited earth for over 24 hours Aug. 6 in *Vostok II*, the USSR's second manned orbital vehicle. His jaunt took him over every continent at least once. (See p. 15).

NASA Budget Cuts

NASA officials are trying to determine the effect of Congressional budget cuts of $112 million which reduced its fiscal 1962 appropriations to $1,671,750,000.

The cut included $19.9 million in salaries and expenses, $75.5 million in R & D, and $17 million in construction funds.

Officials said that while the fund reduction will hurt, no major program will be dropped because of it.

The officials pointed out that the Space Agency can—if it wishes—ask Congress for additional supplemental appropriations next January.

No decision on that point is expected to be made for quite some time.

Titan Door Falls

Five workmen were killed and eight injured when a massive 58-ton *Titan* silo door banged shut without warning.

A spokesman at the Buckley Field, Colo. *Titan* complex said the door fell either because of hydraulic failure or failure of a retaining wall. Witnesses said some of the injured jumped into safety nets placed at intervals in the 165-ft. silo.

Saturn Bypasses Dam

The *Saturn* booster is being towed down-river towards its Cape Canaveral launch-site again after portage of an impassable Tennessee River lock.

The large booster was transported from Huntsville to above the broken lock at Wheeler Dam, Ala., aboard the original *Saturn* barge, Palaemon. It was then trucked one mile around the lock and loaded aboard a second barge, the Compromise, a former Navy dry-cargo vessel, for the rest of the trip. A dummy load was portaged to verify loading and unloading procedures prior to transferring the live payload.

The *S-I* booster, *S-IV* inert second stage and payload are all scheduled to be at the Cape in two weeks. First test firings of the live first stage are planned for the last quarter of this year.

SNAP Safety Tests

The first of five joint AEC-AFSC tests was held July 31 to verify the safety of nuclear devices in space. A

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100-lb. package of telemetry equipment and flare material was put aboard a Cape Canaveral-launched *Atlas,* which soared to a 500-mile altitude.

The flights are being run to verify analytical and laboratory evidence that SNAP devices will burn up harmlessly when they re-enter the earth's atmosphere.

One objective of the July 31 flight was to determine the capability of Special Weapons Center telemetry equipment which provided re-entry heating data.

More Pure Oxygen Trials

The Air Force is holding the third in a series of tests of man's reactions to living on pure oxygen at 35,000-ft. altitude.

Two AF officers were sealed in a space-cabin simulator August 7 for a scheduled 17-day test at the School of Aviation Medicine, Brooks AFB, Tex. Their diet is dehydrated food and recycled body water.

A school spokesman said use of one gas in a closed space environment would lighten the payload—with a greater simulated altitude "there is less pressure across the cabin walls, and less chance of leakage. Again, lighter walls means a saving in payload weight and of fuel needed for launching, orbital maneuvering, reentry and a soft landing."

NASA to Share Tiros Photos

NASA began a special nine-week international weather observation period last week.

The program is planned to permit world-wide meteorological observation synchronized with passes of the *Tiros III* meteorological satellite.

An attempt will be made to obtain cloud-cover photographs over all geographic areas within the 48-degree orbital path of the satellite. Special consideration will be given to the observation of any unusual weather activity such as tropical storms, hurricanes and typhoons.

Tiros III was launched on July 12, and has transmitted over 6000 photographs.

During the nine-week period, the Weather Bureau will transmit the results of their analysis of the *Tiros* photographs over an international weather communications network.



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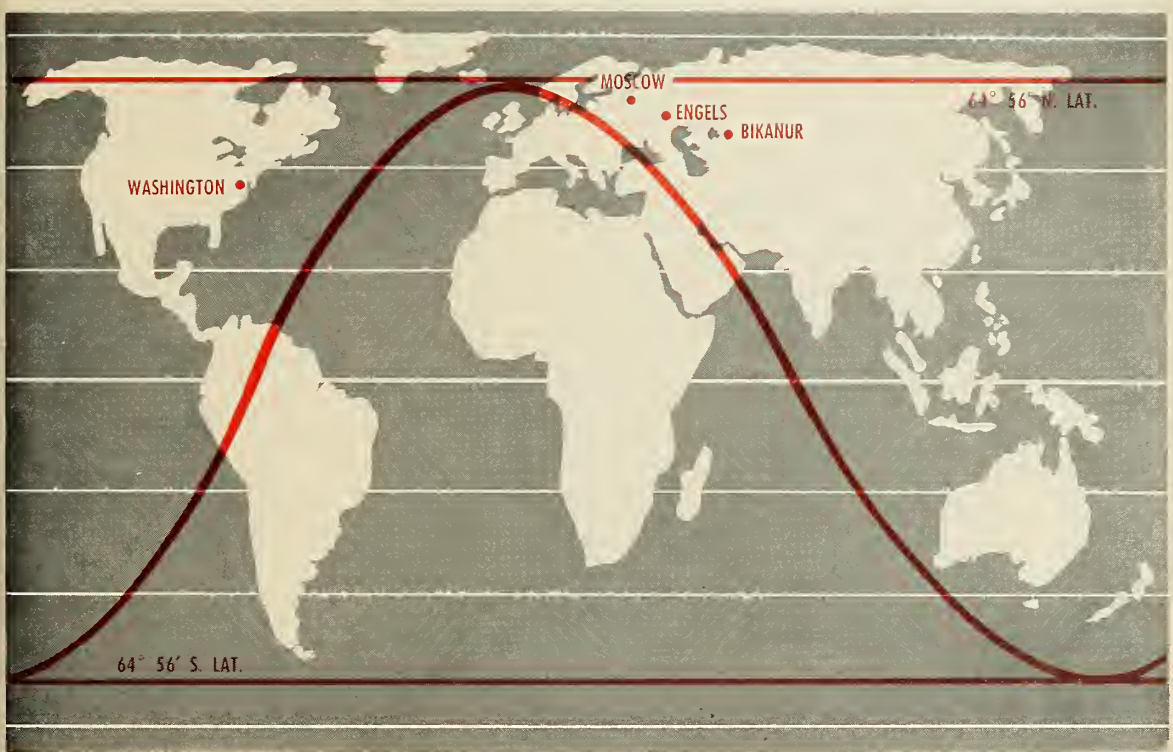
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Vostok II supplies . . .

Push to Speed Up Dyna-Soar

But Administration is still unconvinced of requirement



MAP SHOWS ONE of the 17½ orbits made by Vostok II.

by James Baar

THE SENSATIONAL orbiting of Russia's *Vostok II* spacecraft is giving a hard forward push to Air Force arguments for a major acceleration of the *Dyna-Soar* program.

However, the Administration—and particularly the Defense Department's top civilian command—has yet to be convinced of the growing Soviet military space threat against which the Air Force has repeatedly warned.

The official Defense Department position on the flight of *Vostok II* was that it involved the scientific exploration of space. All requests for comment were referred to NASA.

This position was in accord with the official Moscow line that the *Vostok II* launching was merely the latest Soviet step in the peaceful conquest of space—and with the Administration policy that the all-out program to develop manned spacecraft is the mission of NASA.

• **No further speed-up**—NASA officials said the *Mercury* man-in-space program and the recently accelerated *Apollo* man-to-the-moon program are now moving as rapidly as possible. They said they had no plans for a further acceleration.

A reorganization of NASA to handle the huge *Apollo* program is expected shortly. Congress this last week gave final approval to the $1.7-billion NASA budget—nearly one third of it for *Apollo*—and sent the big money bill to the White House.

The next attempt to launch an *Atlas* capsule into orbit for the first time is still scheduled for next month. If the launching succeeds, it is barely possible NASA may drop the next step: the launching of a monkey-carrying *Mercury* capsule into orbit. That could make possible the launching of a manned capsule before the end of the year.

In general, despite some congressional grumbling, NASA and the Administration appeared to shrug off the flight of the *Vostok II* and move on with getting *Apollo* under way.

• **New alarm**—However, as the *Vostok II* made peaceful passes over all of the continents of the world, a number of military and civilian space experts privately expressed new alarm at Russia's progress in the development of military spacecraft.

They noted pointedly that NASA's planned *Apollo* spacecraft will lack the



MAJ. G. S. TITOV shown entering Vostok simulator during training for Aug. 6 flight.

capabilities for military operations in near space, and that the far less emphasized *Dyna-Soar* program and proposed follow-on projects constituted the nation's only miltiary spacecraft under development.

Until fairly recently, the *Dyna-Soar* program has plodded forward with only rather limited funding. Administration support was generally reluctant at best.

The Kennedy Administration added $30 million to the Eisenhower Administration's request for $70 million for the program in the FY '62 budget. Previously a total of about $100 million had been appropriated through FY '61.

The Air Force Systems Command has completed within the last few weeks a lengthy study of proposals aimed at accelerating *Dyna-Soar* two to three years. The study is now "under review" at the Pentagon.

• **Congress sold**—The proposals, generally referred to as Project Streamline, prompted the House to add $85.8 million to the defense appropriations bill for FY '62. The money—approved by both houses of Congress—is in addition to the $100 million requested by the Administration.

Project Streamline promises to result in the launching of the first orbital *Dyna-Soar* spacecraft about 1964, rather than 1966 or possibly 1967.

The acceleration is based on the making of two major program decisions: One is to use *Saturn* as a booster. The second is to use available, less-advanced subsystems.

Industry advocates of Project Streamline told the House Subcommittee that the plan had the added benefit of shaving the total cost of the program by $300 million. Last year the Air Force estimated that the program would cost about $838 million through FY '66.

• **Pentagon cold**—The Administration's initial reaction to Project Streamline and the House increase has been somewhat frigid.

Deputy Defense Secretary Roswell Gilpatric bluntly told the Senate Defense Appropriations Subcommittee last month that "we just don't think we need this much" money. Defense Secretary Robert McNamara offered only to study the matter.

The Air Force prepared its proposals for McNamara to study.

The overall significance of these proposals is not the $85-million increase but the fact that they could give the United States a major manned military spacecraft R&D program for the first time.

The flight of the *Vostok II* emphasized anew to many military strategists that such a program would be pushed forward barely in time—if it is not already too late.

They have contended that the Soviets are driving for the military control of space from the Earth to the moon.

The *Vostok I* and *Vostok II* are seen not as king-size *Mercury* capsules but as prototypes of a possibly-winged military spacecraft that could later be armed with space-to-space, space-to-air, space-to-surface and anti-missile missiles.

• **Kamikazes?**—The evidence that the *Vostoks* are the forerunners of operational military spacecraft mounted with the release of details about the flight of the *Vostok II*.

The *Vostok II* was reported to have landed in the same plowed area near the Volga that the *Vostok I* came down in last April. Maj. Gherman S. Titov, the *Vostok II's* 26-year-old Red Air Force pilot, indicated strongly that he was able to fly his spacecraft much as pilots will be able to fly the winged *Dyna-Soar*.

"My spaceship was a very smart machine and it was very easy to guide," Titov told a press conference.

The next day in Moscow he said the *Vostok II* could be guided by manual controls to any spot on the globe.

This is precisely the kind of maneuverability that the Air Force has insisted must be built into a spacecraft to make it militarily useful in near space. However, because of the weight penalties that must be paid to provide such maneuvcrability, *Mercury* does not have it at all and *Apollo* will have it only to a relatively small degree.

Soviet Premier Nikita Khrushchev, in his usual subtle manner, told a Moscow crowd with considerable accuracy where the United States and Russia stood in the development of operational spacecraft.

"The Americans do not launch," he said. "Their men only jump upwards and fall into the ocean."

Technically, not even the successful launching of a manned *Mercury* capsule into orbit would force any radical alteration of this statement. ⁂

'I am going to sleep . . .'

Details of Titov's 17½-Orbit Flight

Russians report 434,960-mile shot was successful all the way; skeptics given choice of tracking frequencies

EARLY SUNDAY MORNING on Aug. 6 another of the Soviet Union's huge multi-stage space boosters stood on a launching pad in the barren Bikanur-Tyura Tam area west of the Aral Sea.

The five-ton *Vostok II* sat on the rocket's nose, pointing into the sky over the remote Soviet province of Kazakh.

Both the rocket—estimated by some experts to have more than 1.2 million lbs. of thrust—and the big prototype of an early military spacecraft were ready to take a second Russian into orbit around the Earth.

According to a Soviet eyewitness account, Maj. Gherman S. Titov, Russia's No. 2 cosmonaut, arrived at the launch site in a light blue bus. Titov wore an orange space suit. The letters "CCCP" were painted on his space helmet.

Titov climbed a ladder to a platform near the base of the gantry and made a speech to the launch crew and others gathered there. Then he rode in an elevator to the top of the gantry and entered the *Vostok II*.

At T minus 10—8:50 A.M. Moscow Time—an official was reported to have asked Titov how he felt. Titov replied: "I feel fine. Thank you for your attention."

At precisely 9 A.M. Moscow Time (2 A.M. EDT) the booster was reported to have ignited.

"Gathering force it streaks more and more quickly upward like a roaring fiery globe . . ." a Tass report said. 'At a comparatively low height the space ship inclines to the side and flies on its set course into orbit."

" 'I am travelling over the earth, over our native land,' Titov reported over the *Vostok's* radio. 'The ship is travelling smoothly, smoothly . . .' "

Then Tass reported that as the *Vostok* soared into orbit Titov said: "All the best, comrades—till we meet again."

The Russians reported — and the U. S. tracking subsequently confirmed — that the *Vostok II* roared into a 110.3-to-159.3-mile orbit at an angle of 64°56′ to the equator. The orbit carried the *Vostok II* over every continent as it made 17 trips around the Earth.

	Vostok II	*Vostok I*	*MR 4*	*MR 3*
Date	AUG. 6, 1961	APRIL 12, 1961	JULY 21, 1961	MAY 5, 1961
Type	orbital	orbital	suborbital	suborbital
APOGEE-PERIGEE (MILES)	159.3/110.3	187.75/110	118	116.5
DISTANCE (MILES)	434,960	about 25,000	303	302
TOP SPEED (MPH)	17,750	17,400	5280	5100
FLIGHT TIME	25 hrs. 18 min.	108 min.	16 min.	15 min.
CRAFT WEIGHT (LBS.)	10,430	10,460	4040	4040
ROCKET THRUST (LBS.)	1.2 million (est.)	1.2 million (est.)	78,000	78,000
WEIGHTLESSNESS	24 hrs. 59 min.	89.1 min.	5 min.	5 min.

At 10:28 A.M. Moscow Time the *Vostok II* completed its first orbit. Twelve minutes later—3:40 A.M. EDT —Moscow Radio announced that Titov was in space.

• **"Dear Muscovites"**—Clearly hitting at previous expressed doubts about the flight of *Vostok I* in April, the Russians also announced that Titov would be broadcasting over frequencies of 15.765, 20.006 and 43.625 megacycles. They announced a tracking signal was being broadcast on a frequency of 19.995 megacycles. The world was invited to tune in. And it did.

At 12:20 P.M. Moscow Time Titov reported that all was well and that he was eating lunch toward the end of his third orbit. At 3:08 P.M. he reported that he was using the *Vostok's* manual attitude controls.

During the afternoon, Titov reported repeatedly that all was well, that his weightless condition was causing no problems. At 5 P.M., Titov began eating dinner. At 5:42 he again reported a successful use of the manual controls.

And at 6:15 he said good night and went to sleep.

"Dear Muscovites, I am going to sleep," Titov said. "You do as you like . . ."

His pulse was reported to be normal. The relative humidity in the cabin was reported to be about 70 percent, the temperature between 60 to 62.8° F.

While Titov slept, as throughout the flight, Soviet scientists observed his reactions by telemetry and over a TV circuit. At 11:45 P.M. the Russians announced that the flight was "continuing successfully" as the *Vostok* completed its 10th orbit. By now it had travelled 254,200 miles—more than a one-way trip to the moon.

Titov awakened at 2 A.M. He had slept seven and a half hours—25 minutes more than scheduled. In the next hours he did some setting-up exercises, continued to report that he felt well and ate a third meal.

• **Down to earth**—Finally, at 10:18 A.M. Moscow Time, after 17 and a half orbits, the *Vostok II* landed near Engels, an industrial city on the Volga River about 450 miles southeast of Moscow. It was the same area in which the *Vostok I* had landed last April 12 after only one orbit around the Earth.

Titov, the only man ever to have travelled the staggering distance of 434,960 miles in so short a time, was reported in good condition.

"I kiss you and embrace you by telephone for the time being," Soviet Premier Nikita Khrushchev bubbled to Titov in a phone conversation. Then Titov was hustled off for medical examinations before a gala reception in Moscow.

"All the systems and equipment of the ship worked perfectly," Titov said. ❖

S-3 to Measure Space Dust Phenomena

Satellite will carry six experiments for observing Van Allen belts and beyond during 31-day orbital period

NASA WILL ATTEMPT this week to launch the first of a series of four satellites designed to make detailed observations of the Van Allen radiation belts and energetic space particles.

The satellites will also study solar wind, the interplanetary magnetic fields and the distant regions of the earth's magnetic field.

Dubbed the *S-3*, the first satellite will be launched from Cape Canaveral into an eccentric orbit extending from a perigee of 170 miles to an apogee of about 54,000 miles. The 83-lb. spacecraft will have an orbital period of 31 days.

The *S-3* contains six experiments to measure the entire space particle spectra ranging from energies of a few electron volts to 10 billion, or more than 10 decades of energy. A magnetometer on a boom some 32 inches from the satellite body will determine the particles' interaction with magnetic fields.

At its highest altitude, the satellite will be in interplanetary space beyond the influence of the earth's magnetic field. In that area, electron and proton particles — the building blocks of matter—normally are less than 100 to the cubic inch and slow moving.

The number of cosmic rays—also possessing high energies — are even smaller, less than one to the cubic yard, but the interplanetary magnetic field still influences a particle's motion with a force of about one ten-thousandth the strength of the earth's magnetic field.

As the satellite moves away from maximum height, it will traverse the Van Allen Radiation belts twice during each 31-hour orbital period.

The belts surround the earth at latitudes of less than 70 degrees and between 600 and 30,000 miles, and are essentially storage bins for energetic particles which are trapped by the earth's magnetic field.

Geophysical phenomena created when these particles sift down into the atmosphere include communications blackouts and disturbances, magnetic storms, and auroral — Northern and Southern Lights — displays.

The primary objective of *S-3* will be to describe completely the trapped corpuscular radiation, solar particles, cosmic radiation, the solar winds, and to correlate the particle phenomena with magnetic field observation.

• **Payload** — Its experiments include:

—Proton Analyzer Experiment — To measure low-energy proton flux and spectrum in space beyond 6 earth radii (24,000 miles). These particles are believed to account for 85% of the energized particles in space. Data obtained will increase our knowledge of proton concentrations in solar winds caused by solar flares.

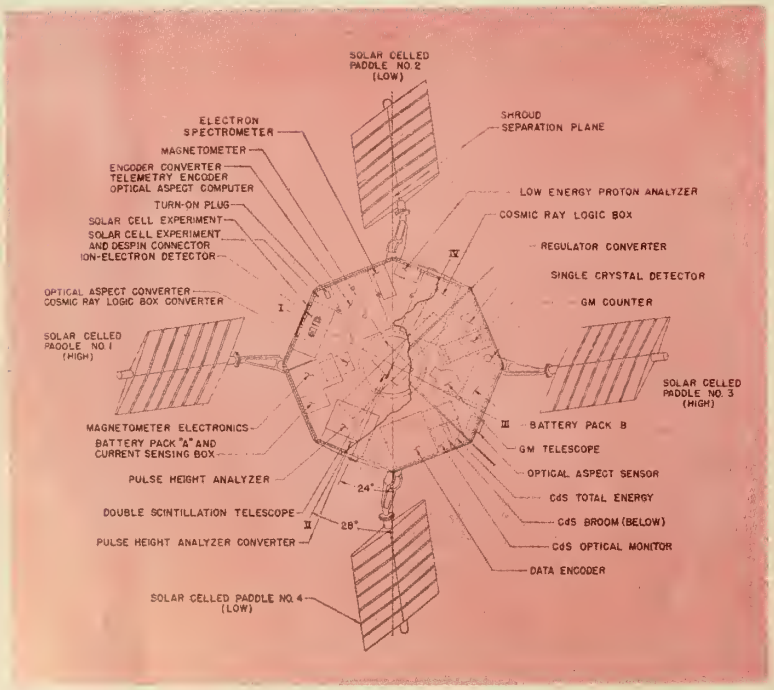
—Magnetic field experiment — Designed to measure the magnitude and direction of the earth's magnetic field between 3 and 10 earth radii (12,000 and 40,000 miles) as accurately as possible. It will also measure the possible termination of the geomagnetic field in the vicinity of 10 earth radii (40,000 miles). The data will be used to determine the existence of postulated extraterrestrial current systems and magnetic disturbances, particularly in relation to solar events and changes in particle intensities.

—Cosmic Ray experiment — To measure particle radiation—trapped particles, solar particles, and cosmic rays —over the entire spacecraft orbit to determine their fluxes and energies and spatial and temporal dependence.

Cosmic Ray experiment—To study the nature of the accelerating mechanism and the nature of the modulation mechanism which produce the 11-year solar cycle variation and Forbush-type decrease.

—Ion Electron Detector experiment

(Continued on page 39)



DETAILS OF INSTRUMENTATION on NASA's S-3 satellite.

250,000 lbs. thrust . . .

UTC Fires Flightweight 40-ton Solid

UNITED Technology Corp. contends it has taken a giant step toward a 3-million-lb.-thrust solid booster with the firing of a 40-ton segmented solid motor with a flightweight case.

The test vehicle produced approximately 250,000 lbs. thrust in an 80-sec. firing Aug. 5 at the company's Morgan Hill, Calif., development center. UTC said it was the first time that a lightweight steel case of flight design had been successfully used in a test vehicle of this size—26.5 ft. long and 7.5 ft. in diameter.

It also was the first time that a prototype propellant charge of the thickness required for space boosters had been used.

The three-segment rocket motor contained nearly 40 tons of propellant with the majority of this—30 tons—in the center segment.

Although the motor was developed from UTC resources, the firing was sponsored by NASA as part of its solid-propellant program.

B. R. Adelman, executive vice-president of UTC, commented that the firing "demonstrated that solid-fueled, segmented rocket motors of multimillion-pound thrust levels utilizing the lightweight hardware and actual propellant and charge configuration can be fabricated . . . and, when the button is pushed, will operate reliably and efficiently."

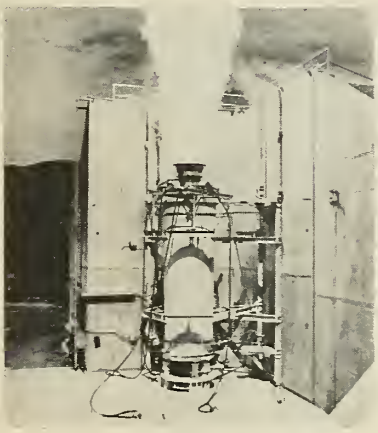


PHOTO of firing. UTC claimed it was a "first" in two important categories.

Before the end of this year, UTC plans to test a rocket engine of similar design but producing 500,000 lbs. thrust.

• **Motor details** — The composite propellant had a specific impulse of 245 sec. at 1000 psi chamber pressure. Both the core and the case of the two-segment motor had a one-and-a-half degree taper.

Designation of the motor is now "P-1"—which was changed from the original S-1 designation due to confusion with *Saturn* stages.

Core was circular in cross section. Mass fraction was .88, and UTC feels the P-1 is essentially an operational configuration. The pressure-time curve for the 80-sec. firing was almost exactly as predicted.

The only part of the test program which failed was a thrust-vector-control system which was not part of UTC's contract with NASA, but which company engineers decided to test. A freon-injection system, the failure did not detract from other test results.

The motor had a fixed nozzle and a pyrogen-type igniter. The case, made of H-11 steel, might be re-used pending inspection. Company officials said it "hardly got warm" during the firing, indicating no insulation problems cropped up.

Engineers were pleased with the fact that the firing time of the test, decided weeks previously, was met to the very second. ⌗

Pentagon R&E Chief Calls for 'Building Blocks'

SAN FRANCISCO—Unless the U. S. lunar program pursues a policy of standardization rather than optimization, DOD's Harold Brown believes "we can easily spend $20-40 billion and still wind up a poor second."

The Director of Defense Research and Engineering, interviewed at the American Astronautical Society meeting, said DOD is pushing a philosophy of "standardized building blocks" to achieve high space vehicle reliability.

"We must build standardized building blocks in boosters, in upper stages, in final stage vehicles and spacecraft," he said. "There must be only a very few different systems for telemetering, for supplying power, for stabilizing in orbit. If we do that, the flights and experiments in our space program are likely to work.

"We are going to strive very hard to have a series of building blocks in the various areas of concern—propulsion, telemetering, power supplies — which are a factor of several apart in their capacity," Brown said.

"If a mission arises which takes a payload 50% too big for one of those arrangements of building blocks, we will go to the next bigger one, even if that provides too much payload capacity by a factor of two. This is somewhat wasteful, but it is very much less wasteful than building a new vehicle for the purpose."

• **Too many sin**—Analyzing what he called space program "failures" over the past five years, Brown conceded that the U. S. had suffered from a late start. But he said a "less forgivable" reason for lagging behind Russia "has been the practice of building a separate vehicle for almost every payload, of building too many different stabilization systems for satellites, too many different power supplies into our satellites and space vehicles and too many telemetering systems."

Brown said there had been more than 15 prime booster and upper-stage vehicle combinations.

"The reliability achieved in this way has been just what you might expect—not good. The ratio of space vehicles put into orbit to those attempted to be put into orbit is roughly 50% out of over 80 launches."

He noted that the *Thor-Agena* combination, responsible for about a third of the launches, had a record approaching 70% success in putting payloads into orbit. He called this a good example of "the way in which reliability increases with the number of launches of a standardized vehicle."

Brown said another mistake had been the tendency to try to get "every last possibility of performance out of each component, with consequent degradation in reliability and increased complication." ⌗



SOLID SUCCESS

On August 5, 1961, United Technology Corporation successfully test-fired the nation's first operational prototype segmented solid propellant rocket developing thrust in excess of 200,000 pounds. This major achievement is a significant milestone in the national program to develop multi-million-pound thrust boosters.

UNITED TECHNOLOGY CORPORATION

A subsidiary of United Aircraft Corporation

P. O. Box 358, Sunnyvale, California

Capability backed by four decades of propulsion experience

Technical Countdown

PROPULSION

Too Much "Me Too-ism"?

The Air Force reportedly made a serious mistake in insisting on a four-nozzle design for the *Minuteman* ICBM. Influenced by the successful *Polaris* design, which uses four nozzles because overall length is thereby reduced, the Air Force ignored advice that a single gimballed nozzle be used on *Minuteman*. A single nozzle, AF now privately admits, would be devoid of internal turbulent-flow problems which caused so many motor failures before being solved. One source says the missile would be almost completely operational now instead of still being in early test flights if the Air Force had listened. The trend reportedly went so far as to cause a four-nozzle-design for *Skybolt* before pressure forced adoption of the present single-nozzle approach which is working extremely well.

J-2 Test Stand Being Modified

Rocketdyne is modifying its test stand for the J-2 engine being developed for NASA so that full-power tests of the 200,000-lb. thrust unit can be made at the Propulsion Field Laboratory. Modifications include an altitude simulation capability of 60,000 ft. on one stand—plus additional liquid oxygen and liquid hydrogen facilities. Rocketdyne is consuming liquid hydrogen at the present rate of 200,000 gallons per month and expects to boost this to about 600,000 gallons per month by 1962.

Dat Ol' Debbil Rust

The Army was quite disturbed to find *Hawk* motor nozzles rusting away under their Rokide coatings recently, and has taken steps to coat the nozzles with a vinyl covering in addition to the Rokide.

Plug Nozzle For Polaris

The Navy is considering the use of plug nozzles on its *Polaris* fleet ballistic missile to add efficiency and shorten the missile so that more propellant can be used. A plug nozzle configuration would simplify thrust vector control problems and increase reliability by reducing seal failures. The change is expected to be a significant contribution to the to the Navy's aim of a 2500-mile range *Polaris*.

ADVANCED MATERIALS

ARC Slurry Fuel Funded

Multi-component fuels for rockets and ram-jets will be studied by Atlantic Research under a $250,000 Air Force contract. The work will involve liquid propellant systems containing liquid oxidizers, heat liberating metallic fuels and a gas-forming third material. Such slurry systems maximize impulse per unit weight and have been researched for several years at the firm.

Saturn S-IV Stage Goes Aluminum

Alcoa is supplying aluminum alloy 2014 skin plate for the *Saturn S-IV* liquid hydrogen upper stage. Bulkheads will be of aluminum sheet and plate. Forgings and extrusions of the same metal are being incorporated into the rocket's structural framework.

Tungsten Alloy Strip Form Castings

Experimental production of tungsten alloy strip from centrifugally cast material is underway at Oregon Metallurgical Corp. The cast material is directly rollable to strip with no forging breakdown or extruding necessary.

Hydrostatic Press Operational

Powdered metal forms up to 5 ft. long and a foot in diameter are being fabricated in Allegheny Ludlum's new 50,000-lb. hydrostatic press. The output goes for long boring bars, steel mill rolls, billets for consumable arc melting and nuclear fuel elements.

ELECTRONICS

"Blue" Cells Yield Higher Outputs

Solar cells with an increased response to the blue regions of the color spectrum are said to be capable of delivering from 9.5 to 10 watts per square foot of cell panel surface against about 8.5 watts for older cell types. Developed by Hoffman Electronics, the shallow junction cell with a thinner diffused surface is expected to outlast previous types in high energy radiation environments.

Reliability Increased with Glass Capacitors

Glass capacitors with a reliability of 99.9994% during 1000 operating hours have been produced by Corning Glass Works for use in the *Minuteman* ICBM inertial guidance and flight control systems built by Autonetics Division, North American Aviation. Confidence level for the reliability is 60%—an improvement of 100 times that of standard military-type capacitors available two years ago or a failure rate possibility of six out of every one million.

LIFE SUPPORT

Equilibrated Astronauts?

The next Soviet astronaut (Maj. Titov) should be a "strong, equilibrated, mobile" type of individual, says V. I. Danyleyko in the USSR's Physiological Journal. The Pavlovian physiologist cited U.S. test results on human beings under prolonged isolation conditions, but rejects them as not proving anything fundamental for the theory and practice of space medicine. The whole thing shows close Soviet interest in U.S. space medicine. However, Danyleyko maintains Soviet experiments in space flight ecology were executed independently.

SUPPORT EQUIPMENT

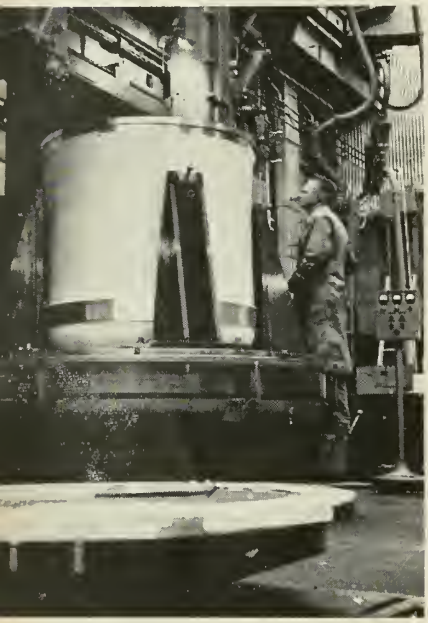
Helicopters to Simulate Missile Launch

The H-43B HUSKIE helicopter will be used to simulate missile launch conditions in order to test and calibrate guidance systems at *Titan* ICBM bases. Modified to function as a flying electronics platform, the H-43B will be required to hold a tightly restricted flight envelope in order to perform the checkout operations.

Crucial Rover Rocket Program Picks Up

Varied Nerva core concepts to be tested; flight safety office formed; all ground tests slated for Nevada

by Frank G. McGuire



BOTTOM HALF of Kiwi-B1A pressure vessel is finish-machined at ACF/Albuquerque facility on one of the firm's eight vertical boring mills. After operation is completed, two halves of the vessel are joined with a circumferential weld and finish-machined again.

NEW EMPHASIS placed on the *Rover* nuclear rocket program in the nation's space effort has already given the program several visible pushes forward.

A variety of core concepts will be tested within a standardized configuration in the Kiwi-B series. This will determine the optimum reactor design for the Nerva engine to be built by an Aerojet-Westinghouse team.

At the same time, a *Rover* Flight Safety Office (RFS) has been formed at Los Alamos Scientific Laboratory to study problems arising from nuclear rocket flights.

And the Jackass Flats area of AEC's Nevada Test Site has been designated the National Nuclear Rocket Development Center, for ground-testing of all nuclear rockets.

One minor delay is resulting from an old problem: some 20 employees of the Aerojet-Westinghouse team have been unable to move to Los Alamos because of the chronic absence of housing there (M/R, Aug. 1, 1960, p. 11).

Designed by Los Alamos Scientific Laboratory, the Kiwi-B series of reactors represents the second major phase of the *Rover* program, and will begin static testing at full power later this year. The first in the group, Kiwi-B-1A, is undergoing assembly and checkout at the Nevada Test Site (NTS) now, and will probably be the only one in the series to use gaseous hydrogen.

Later reactors in the Kiwi-B series will be operated with liquid hydrogen, unless design problems force a temporary retreat to gaseous coolant/propellant. LASL spokesmen point out that the test cells to be used have a dual capability for either the gas or liquid.

Kiwi-B is significantly different from its predecessor series, Kiwi-A. Ducting is simpler, a more rocket-like nozzle is used, and the pressure vessel is about one-third smaller. Additionally, there is a very slight coke-bottle effect in the Kiwi-B pressure vessel shown, but LASL says the mild pinch has no significance. The vessel is 50 in. in diameter and uses a 4½-in-thick skin. The bottom half is larger than the top and is drawn in 67 seconds.

The pressure vessel is composed of an aluminum alloy, with the two pieces being joined by one deep aluminum heliarc girth weld.

Although this pressure vessel will be standard, as will the complete external design of the reactors, cores will be made relatively interchangeable so that a minimum of re-work will be needed to check various core geometries during the test program.

Fabrication of most non-nuclear components in the *Rover* program has been handled by a 160-man group of ACF Industries' Albuquerque Division. This facility also designs and fabricates test cars and support equipment for reactor assembly and disassembly.

ACF began work on the *Rover* program in 1956, producing hardware for Kiwi-A, Kiwi-A-Prime, and Kiwi-A3. The firm began design work on the Kiwi-B series in 1958. Current work is centered about the cryogenics problems expected with succeeding Kiwi-B reactors.

• **Start for Nerva**—Presumably, the final design to come out of the Kiwi-B series will be the starting point for the Nerva engine contractors. A prototype nuclear engine consisting of all basic components may be in industry hands by mid-1962 if all goes well in the Kiwi-B tests.

Development of the reactor, liquid hydrogen turbopumps, liquid hydrogen cooled nozzle, and overall system controls is expected to be more or less completed with Kiwi-B. An estimated 3 to 5 full-power runs with liquid hydrogen and Kiwi-B hardware will take place during 1962, following the first run with gaseous hydrogen in Kiwi-B-1A during late 1961.

LASL plans to use "push button testing" to the maximum for the Kiwi-B phase, having highly automated the test setup. The automation is seen as a step toward fast start-up and precise control of a flying nuclear rocket. Test runs will henceforth use automatic programers during the entire full-power operation, in contrast to partially-automated previous tests.

Kiwi-A reactors also used a calculation derived from fission rate and propellant flow to determine exit gas temperature, leaving room for significant error due to calibration inaccuracies. Kiwi-B reactors will have direct measurement of the exit gas temperature through a new control system.

Tungsten thermocouples, previously

tested in full-power runs, will be located so as to measure the gas temperature, compare it with the programed requirement, and then adjust the reactor power to maintain the desired temperature. This will enable LASL scientists to control temperature and flow independently, with power automatically adjusted to meet the demand.

NTS control room changes reflect the future use of liquid hydrogen, being completely revamped with a streamlined data processing system. Magnetic tape, IBM 704 computers and other data handling techniques not formerly used, will reduce the time lag between test and analysis from months to one week.

A sampling technique will replace the former constant-measurement method and will put the sampled data through a transducer-amplifier system. An arrangement of switches will sweep around a series of 45 samples at a rate of ten samples per second. FM signals are then transmitted via coaxial cable to the control room, where magnetic tape will store them.

Tape language translators convert the signals into digital imputs for the 704, with the capability of retrieving vital data being a part of the setup. Pertinent information can be removed from the tape at NTS and the remainder flown to LASL for study.

Instead of the previous one-link-per-measurement system, the new arrangement allows one data transmission link for every 45 measurements. Program spokesmen say for the approximately 500 measurements to be made in the Kiwi-B series, only ten data links are needed.

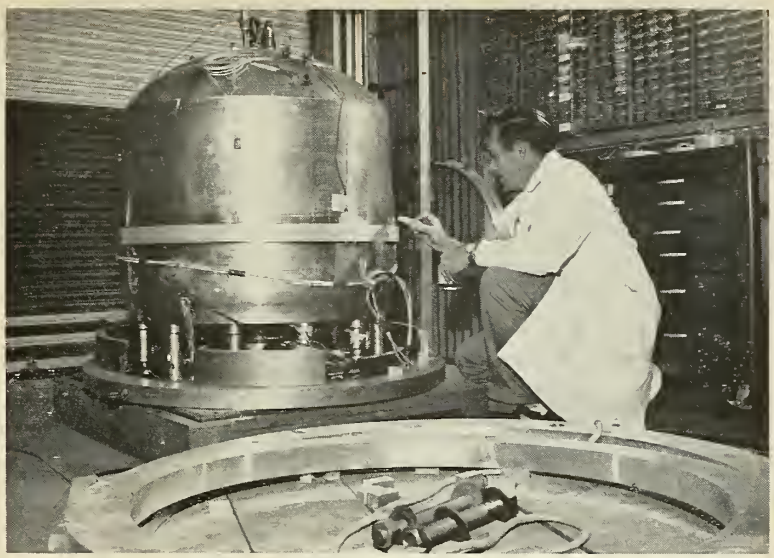
• **Flight Safety Office**—The RFS office is expected to work across internal division lines at LASL and emphasize public safety, particularly with the breed of reactor now under development at the laboratory.

The new office is headed by LASL's L. D. P. King, who will also advise AEC-NASA on safe launching operations and disposal of a nuclear rocket, if necessary.

Specific studies in the RFS office include:

(1) Can chemical processes destroy a reactor, either through explosives or high temperature? Experiments will be

(Continued on page 45)

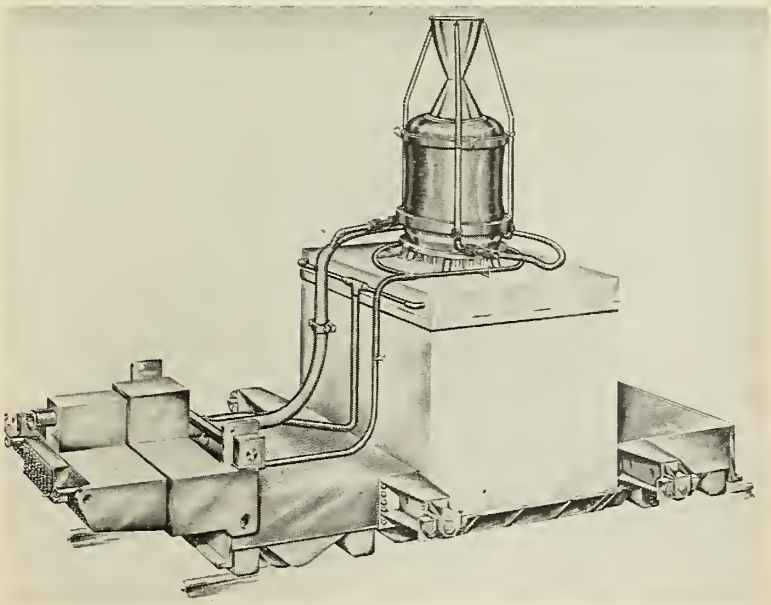




LEFT: *Stress determination within the pressure vessel during operation is made with strain gages, shown here being installed by ACF technician.*

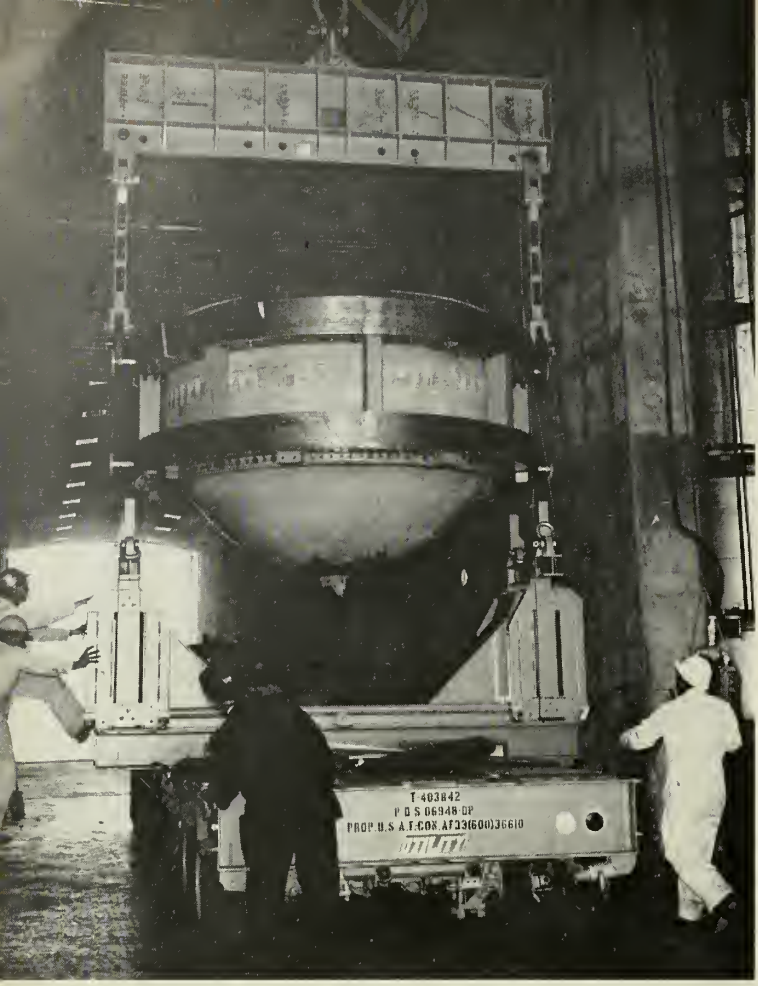
ABOVE: *Scaled-down model of Kiwi-B pressure vessel is checked for leaks at ACF cryogenics testing laboratory. Seals are biggest problem in system, due to use of liquid hydrogen.*

BELOW: *Described by ACF as more difficult to design, but easier to fabricate than Kiwi-A series, the Kiwi-B models of the Rover nuclear rocket program will use a simpler configuration closer to flight versions. Large square housing under reactor-pressure vessel houses instrumentation, control rods, and other equipment involved in reactor operation.*

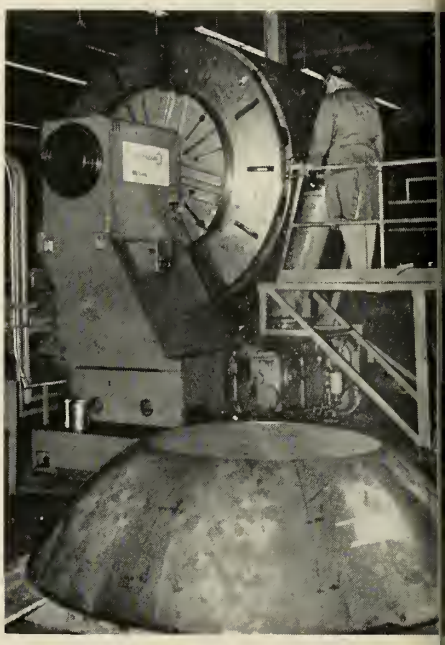


Aerojet Is Nov

Half-million-lb. version fired successfully; 'big one' slated to be tested this year; total funding could reach $2 billion







UPPER LEFT: *Head segment of the 500,000-lb.-thrust solid motor is readied for shipment to the test area. The unit contains live propellant.*

LOWER LEFT: *Ultrasonic wall thickness test is run on the forward head of the motor. The ring attached to the edge of the dome is part of Aerojet's joint assembly.*

ABOVE: *Massive cylindrical section is machined on one of the giant lathes. The 100-in.-diameter section is then welded to a second, similar part to form a chamber segment.*

Halfway to Goal of Million-lb. Thrust

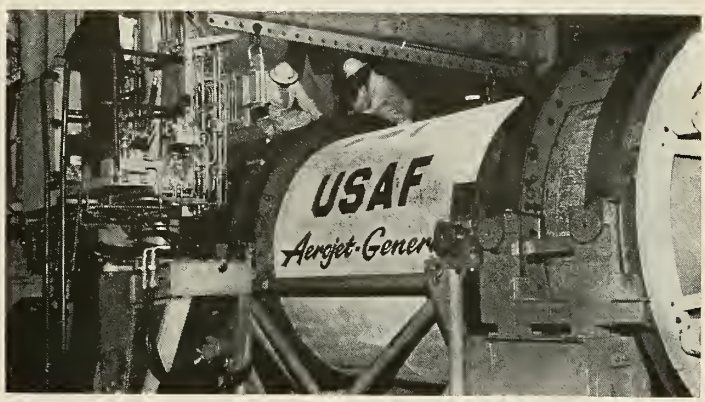
THE SUCCESSFUL FIRING of a 55-ton, 500,000-lb.-thrust segmented solid motor by Aerojet-General puts the firm within striking distance of the magic million-lb.-thrust motor.

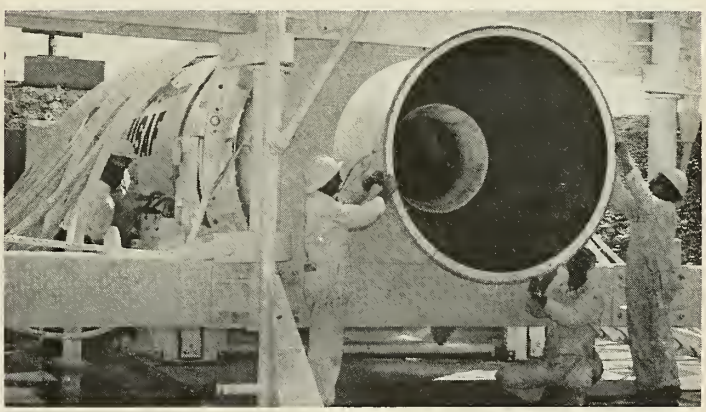
Current schedules call for the big one to be fired later this year.

The segmented program at the firm has received Air Force support totalling $5.8 million to date. Defense Secretary McNamara has estimated that the overall development cost for the big solid boosters will hit $500 million, with $62 million to be spent in fiscal '62—$50 million for motor development and $12 million for supporting facilities.

If large solids are used for military space work, in addition to *Nova,* Major General R. J. Friedman, USAF Budget Director, estimates the total in the $1.5—$2 billion area.

Large solid systems could be used for *Nova* booster stages, *Saturn C-3* boosters and military space systems.

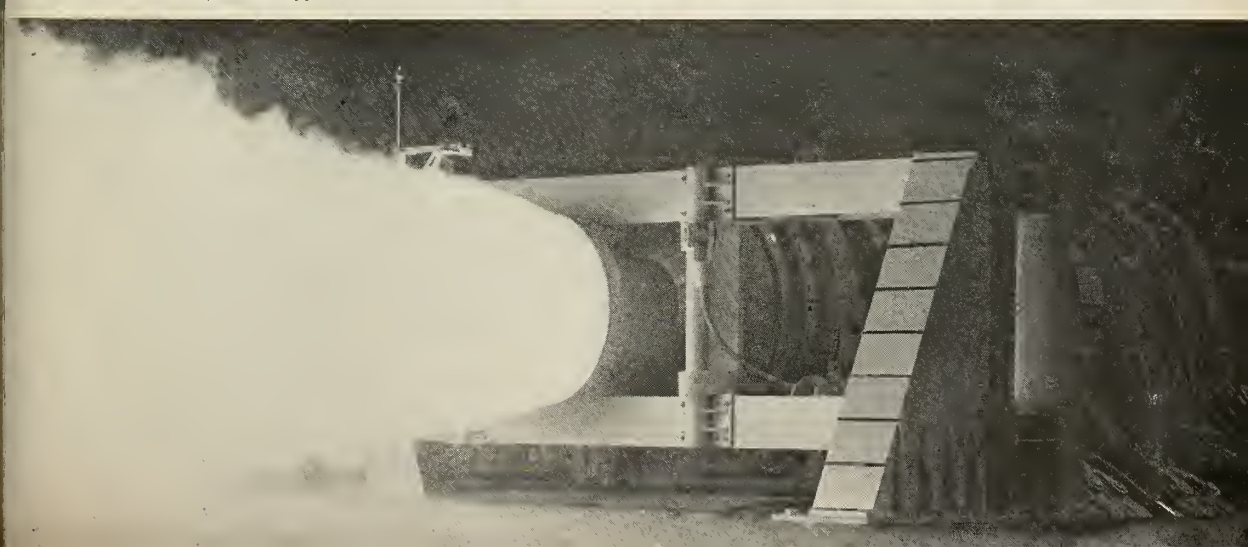




UPPER RIGHT: *Joining the three segments involves this huge holding fixture. Aerojet's locking concept allows completion of the operation in less than 5 minutes.*

RIGHT: *The 55-ton motor is securely mated to the test stand. Nearly 50 tons of propellant are contained in the three-part propulsion unit.*

BELOW: *Full duration firing generated nearly 500,000-lbs of thrust and demonstrated the feasibility of the firm's segmented approach.*



Monomer Casting May Produce Bi

Polymer Corp. has rights to Monsanto-developed method, is taking aim on markets now dominated by metal castings

by John F. Judge

A NEW NYLON casting process perfected by Polymer Corp., Reading, Pa., may lead to the use of massive nylon shapes in the missile/space industry.

The revolutionary method is similar in technique and costs to conventional casting of metals, and the firm is aiming specifically at new markets for nylon in areas now dominated by cast metals.

The monomer casting process avoids several steps in conventional nylon manufacture by directly converting raw materials to finished shapes. Raw material costs are cut by about 50%, since the monomer is used instead of the polymer.

The basic chemistry was developed in the laboratories of Monsanto Chemical Co. Polymer Corp. acquired exclusive rights to use the casting process in the U.S. and other countries, and brought the method out of the lab into commercial production. Polymer has cooperated with Monsanto in the filing of many improvement patents covering processing and handling techniques.

• **Size breakthrough**—Conventional fabrication procedures form finished or semi-finished parts from granules of nylon polymer through "melt-pressure" methods. Processing pressures ranging from 100-300 psi in extrusion molding to 20,000 psi in injection molding are required to obtain porosity-free parts. MC nylon (Monomer Cast) is cast from the monomer at atmospheric pressure. The caprolactam monomer melts at 150°F., becoming a mobile liquid which easily fills mold recesses.

All plastics are poor heat conductors, and the temperature rise due to polymerization in most casting resins is trapped in large castings. The rising temperature causes a more rapid rate of reaction which in turn increases the temperature. The system can easily become unstable and destroy the casting. Run-away polymerizations can cause self-ignition. Thus conventional plastic castings have a built-in size limitation.

The polymerization reaction can be governed so that the temperature never exceeds the melting point of the poly-



BELOW: *Large and complex parts can be easily cast with the Polymer monomer process. Detail ability and surface-finish characteristics are obvious in the parts shown. The firm colors its castings a distinctive, deep blue—in effect a built-in product identification.*

Nylon Parts for Missile/Space Structures

mer. This avoids the dangers of self-ignition and permits the casting of almost any size.

The low exotherm of the MC nylon reaction prevents the formation of vacuum bubbles in the center of the casting. Since the boiling point of the monomer is also much higher than the polymer melting point, there is no tendency to form pressure bubbles as a result of monomer vapor pressure.

There are several crucial areas in the process. Production techniques must be timed and controlled to an exacting degree. Careful chemical controls are mandatory and temperature is extremely critical.

Although operations in monomer casting and metal casting are similar, none of the metal techniques can be used directly.

In the first place, MC nylon molds must be non-porous because of the low viscosity of the molten monomer. Polymer Corp. uses permanent molds. Pouring must be at certain exact temperatures and catalysts carefully added. Since the nylon sets up in the mold by chemical polymerization instead of heat loss as with metals, the chemistry of the process becomes critical.

• **Dollar factor**—One main advantage in the new process is cost. At today's prices, conventional nylon fabrication results in approximately doubling the cost of the monomer to the user—$0.46 lb. for monomer to $0.98 for polymer granules. Mold costs for large parts in injection molding may run as high as $5000 or more for a 7 lb. part while an MC part the same size runs mold costs down to between $100 and $500.

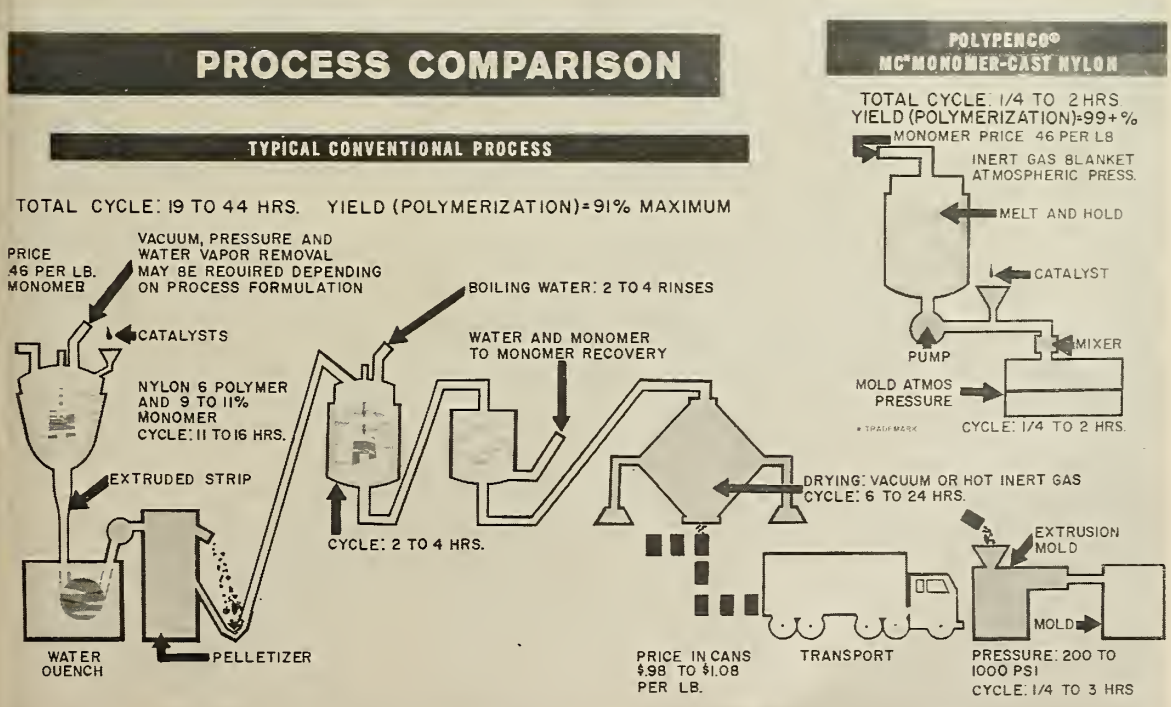
The extrusion tooling costs for an 8-in. diameter rod are about $1500. A monomer casting mold for a 4-ft. rod of the same diameter runs about $100 with a prospective ultimate savings of 50% per part produced.

Polymer spokesmen say that production costs will be lower for the MC Nylon, but increased volume and refinement of mass production methods are required before forecasted production savings can be brought about.

Monomer casting will not compete with injection molding in the production of small parts where mold costs are low per unit volume and injection cycles are as short as 15-30 seconds. Monomer casting would take about 5 minutes per casting cycle for small parts.

• **Combat areas**—Initial market efforts by Polymer will concentrate on those areas where nylon has demonstrated effectiveness and is accepted. But nylon, in spite of years in the field, is still underrated in its ability to outwear metals and other materials in general mechanical applications. The firm has completed dozens of field tests—proving the economic and performance advantages of MC nylon over the "classical" nylon parts currently in use.

Polymer's product attack on the metals field is grounded in the similarity between the new casting process and metal castings. The material is lower in cost than comparable stainless steel, brass or bronze castings and will compete with these metals within nylon's



MC(R) Nylon 901 vs Types 66 and 6 Nylon

Property		Units	A.S.T.M. Method	Type 66 Nylon	Type 6 Nylon	MC Nylon 901
MECHANICAL						
Tensile Strength	73°F	psi	D638	9,000-12,000	9,000-12,000	11,000-14,000
Elongation	73°F	%	D638	25-200	25-250	20-30
Tensile Impact	73°F	ft.-lb./in.^{2}		90-180	40-150	80-100
Shear Strength	73°F	psi	D732	9,600	7,600-8,200	10,500-11,500
Modulus of Elasticity	73°F	psi	D638	400,000	350,000	350,000
Stiffness	73°F	psi	D747	200,000-400,000	230-350,000	200,000-400,000
Hardness, Rockwell	73°F		D785	R110-120	R111-R118	R-118
Deformation under load	122°F 2000 psi	%	D621	1.0-3.0	1.0-2.5	0.5-1.0
THERMAL						
Heat Distortion Temp.	264 psi	°F	D648	200	130-175	400
	66 psi	°F	D648	360	345-365	425
Melting Point		°F	D569	496 plus/minus 9	423 plus/minus 9	430 (Gel Temp.)
Coeff. of linear thermal exposion		in./in./°F	D696	5.5×10^{-5}	5.0×10^{-5}	5.0×10^{-5}
Flammability		in./min.	D635	self-extinguishing	self-extinguishing	self-extinguishing
ELECTRICAL						
Dielectricol Strength Short-time		V/mil	D149	300-400	300-400	500-600
Dielectric Constant	60 cycles		D150	4.1	5.0-14.0	3.7
	10^3 cycles		D150	4.0	4.9-10.1	3.7
	10^6 cycles		D150	3.4	4.0-4.7	3.1
Power Factor	60 cycles		D150	0.014	.06-0.10	.02
	10^3 cycles		D150	0.02	.06-0.11	.02
	10^6 cycles		D150	0.04	.04-0.13	.02
OTHER						
Specific Gravity			D792	1.14-1.15	1.12-1.15	1.16
Water Absorption		%	D570	1.5	1.5-2.0	.9
Water Absorption— Saturation		%	D570	7-9	8-10	5.5-6.5

characteristic limitations.

MC nylon is limited to 250-300°F on prolonged exposure. The material is less rigid than metals having a modulus of 300,000 psi. Nylon fails quickly when attacked by strong acids and metals are 2 to 10 times stronger in tensile strength.

On the other side of the ledger, nylon has advantages in bearing applications, with or without lubrication. It is non-galling to mating surfaces and resists alkali solvents and weak acids. The material has resilence, sound dampening, peen resistance and shock absorption characteristics.

MC nylon is lightweight and has good electrical properties.

The material can be machined at higher speeds than metals and its ability to conform to mating parts permits significant increases in the allowable dimensional tolerances of machine components.

Some of the proven markets include:

—Gears operating under conditions of shock and vibration.

—Large hydraulic backup rings.

—Cams on automatic screw machines.

—A variety of rolling applications including guide blocks, forming fixtures slipper blocks and many bearing and wear uses.

• **Semi-production**—Polymer Corp. has cast certain profiles up to 4 ft. long. Plate shapes and thicknesses up to 4 in. have been made in sizes up to 4 x 8 ft. and weighing over 800 lbs. Depending on part geometry, contour castings can now be made in sizes ranging from 1 to 100 lbs. Larger parts are in the works.

Present as-cast tolerances capabilities are similar to those of sand cast steel, averaging about ±0.030 in. for parts under 1 in. For larger parts, 0.004 in./in. must be added. Guy Koch, Production Manager says that these tolerances will improve with experience.

Any finish available in the mold can be reproduced. Fine detail such as limited undercuts and reverse steps can be cast.

Many of the physical properties, including wear and temperature resistance can be improved through reinforcing methods. Polymer has not yet studied this area to any great extent but plans to do so are under consideration.

The Polymer process represents a brand new technology in plastics. Even though many field tests have been completed, the techniques are still in a very early stage. The potential market areas are varied and extremely wide. ⁂

Air Force Steps Up Solar Tracking Work

THE AIR FORCE is increasing its solar-flare prediction capability, not only for manned space missions but to support the *Samos* and *Midas* reconnaissance satellite programs.

Dr. Knox Taylor Millsaps, Chief Scientist of the Office of Aerospace Research, told M/R at the AAS meeting in San Francisco that the Air Force "would like to know when solar flares are going to affect communications with a satellite. Maybe they'll want to wait until the next pass to read it out."

Solar flare predictions already are being used in AF satellite work, he said. "Right now, we are making two predictions daily from the observation facility at Sacramento Peak, N. M. These go to the Space Systems Division on the West Coast, as well as other places."

Millsaps said the Air Force will double its Sacramento Peak facilities next year. He indicated increased activity also was due at other stations.

"Solar flare prediction must be greatly improved for the manned lunar flight program," he said, pointing out that predictions in this case would be greatly complicated by a very narrow "best-launch" period.

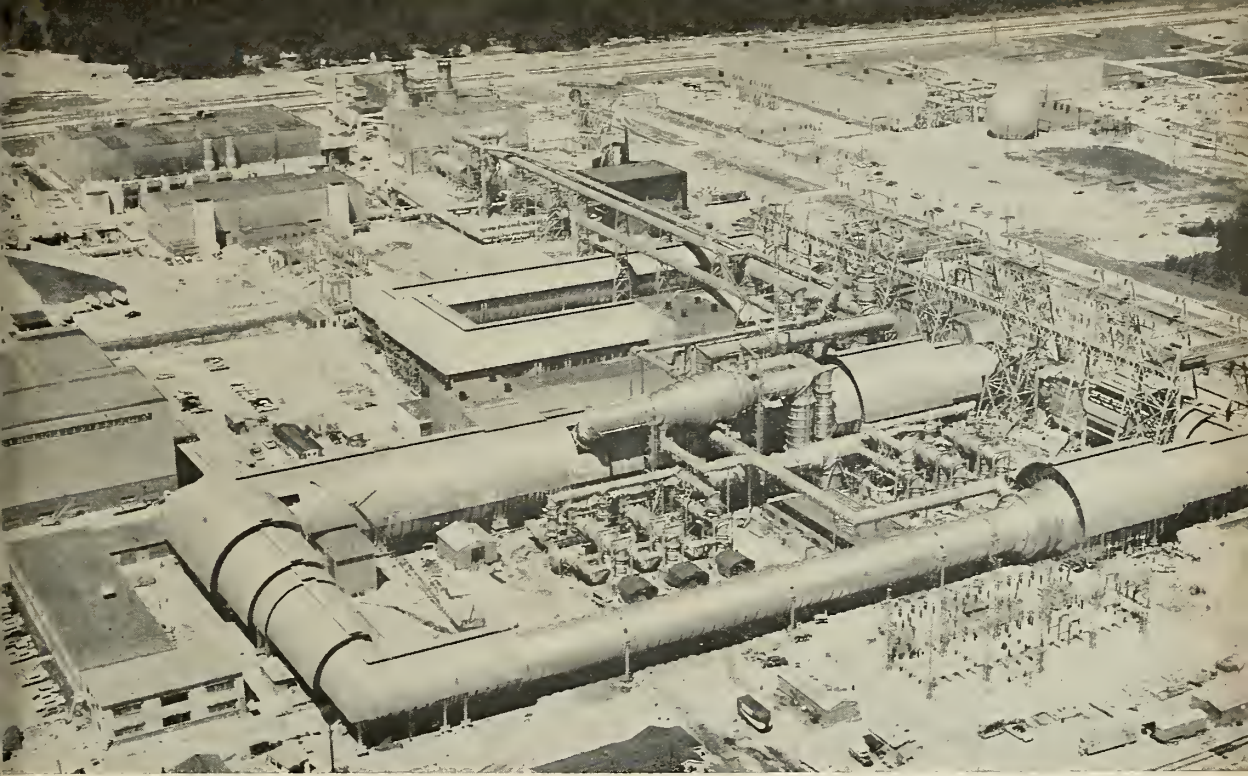
"Right now, we would be able to advise only when not to go," he said. "We would be unable to say ahead of time when a good period would be."

The Defense Department at present considers both *Midas* and *Nike-Zeus* strictly limited in capability, said Dr. Harold Brown, Director of Defense Research and Engineering.

"It seems unlikely we would launch a missile solely on the warning of *Midas,* because it is not believed such a system could be trusted implicitly. We probably would send bombers rather than missiles on the first signal from *Midas,* because bombers can be recalled."

As for *Nike-Zeus,* Brown said it may be 10 years before the U.S. has an anti-ICBM weapon to protect its cities.

"I don't mean to say that *Nike-Zeus* isn't any good," he said, "but the present evaluation is that it could not meet a sophisticated, massive warhead attack. We would have to have so many of the missiles the cost would be prohibitive." ⁂



AERIAL VIEW shows Propulsion Wind Tunnel (foreground), Von Karman Gas Dynamics Facility (right) and Rocket Test Facility (left rear).

test facilities

Arnold Center Tests All Big Systems

Huge complex developed at insistence of 'Hap' Arnold uses three big facilities, is adding more for future

by James Trainor

EARLY in the flight test program of the *Atlas* there were several failures for which there seemed to be no explanation.

At about the same time, satellites were being knocked out of their orbit by re-ignition of the spent third stage—something the experts had said wouldn't happen.

Problems such as these are typically the special province of the Arnold Engineering Development Center—a unique complex of aerodynamic and rocket test facilities which over the past ten years has made significant contributions to every aerospace system.

It was in the Center's Rocket Test Facility that the *Atlas*' troubles were diagnosed as "ballooning"—the tendency of jets at high altitudes to mushroom and flow back, thus heating the missile base and eventually destroying it.

The Rocket Test facility also, in its very first rocket engine test, defined the satellite problem. While testing the third-stage engine of the ill-fated Project *Able,* Arnold engineers witnessed the phenomenon known as "chuffing"—a sporadic continuation of burning beyond the rocket engine's prescribed burnout.

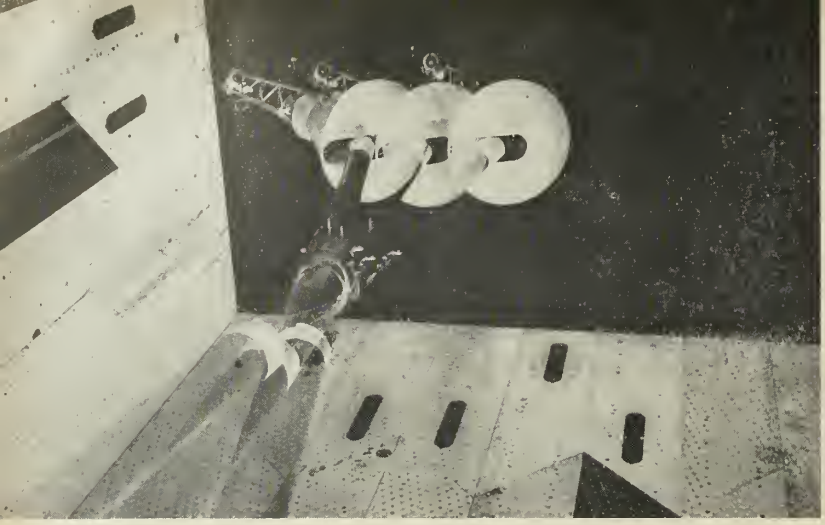
Both of these tests solved major R&D problems chiefly because they were conducted at simulated altitudes where environmental conditions revealed problems not apparent in sea-level testing.

• **Test Programs**—The Arnold Center—operated for the Air Force Systems Command by ARO, Inc., a subsidiary of Sverdrup & Parcel, Inc.—consists of three major facilities: the Rocket Test Facility, the Propulsion Wind Tunnel and the Von Karman Gas Dynamics Facility. In the three, aerodynamic and propulsion tests have been conducted on every major aerospace system developed in the past decade. For example, the *Mercury* capsule has been tested for the validity of its aerodynamic configuration while the escape rockets for the capsule tower were being tested in the rocket facility.

Arnold engineers have also conducted tests on the base-heating, recirculating and heat flux problems of *Saturn,* the staging of *Titan,* the propulsion systems of *Polaris* and *Agena,* the *Agena's* orbital coast and restart capabilities. They have studied the trajectory, attitude control, and even the optimum parachute configuration for the AF's *Discoverer.*

It is safe to predict that when the first *Apollo* spacecraft is launched or the first *Dyna-Soar* pilot glides to a safe landing, both systems will have been thoroughly tested at Arnold.

• **How Arnold operates**—The Arnold Center is not a research organization but rather a developmental test center. The Air Force—almost as a



MULTIPLE-EXPOSURE photo of Mercury capsule model being tested in transonic wind tunnel shows how various angles of attack can be attained by adjusting support.

matter of course now—requires its contractors to test their developmental prototypes at the Arnold facilities.

As a result, several months before the tests are scheduled the contractor begins working with the center's engineers so that the optimum results can be obtained from the test program. Tests in one or more of the facilities are fitted into the crowded schedule, models or full-scale systems are carefully instrumented (some of the more exotic instrumentation being furnished by Arnold's highly competent instrumentation engineers), and finally the tests are run.

From these tests the contractor receives not only a technical report but also the magnetic tape of the reduced data from instrumentation and a printed listing of the test results in scientific language.

Although funded and supported by the Air Force, Arnold is not restricted to testing only AF programs—as evidenced by its extensive work on *Saturn* for NASA, *Sergeant* and *Pershing* for the Army, and *Polaris* for the Navy.

• **History**—The Arnold Engineering Development Center had its start in the concern of Gen. H. H. (Hap) Arnold, wartime boss of the Air Corps, with the U.S.'s lack of aerodynamic test facilities. To determine how this could be remedied, Arnold appointed Dr. Theodore von Karman, one of the world's leading aeronautical scientists, to form a study panel.

Von Karman's recommendations called for establishing a National Facility—costing the then-staggering sum of two billion dollars. This new aerodynamic facility would concentrate all of the elements for effective aerodynamic and engine testing in one area. However, in the period between the von Karman report and the establishment of the Arnold Center, political and fiscal considerations forced some splintering of the facilities.

The TVA area of Tennessee was selected as the site for the Arnold Center only after many other areas were considered. However, the cheap, plentiful power and water available turned the tide in favor of the Tennessee site.

Sverdrup & Parcel, Inc. was selected to run the installation for the Air Force on the basis of its already considerable work in the construction of wind tunnel facilities, in particular the large wind tunnel that it had built at Wright Air Development Center.

Early in 1950, construction on the center began. By 1953, the first laboratory was in operation. The equipment for the facilities, now valued at some $300 million was initially the spoils of war. German and Japanese facilities—discarded by the British and the U.S. Navy—were grabbed by the Air Force and shipped to the center. There they were molded into the complex that is now the Arnold Center.

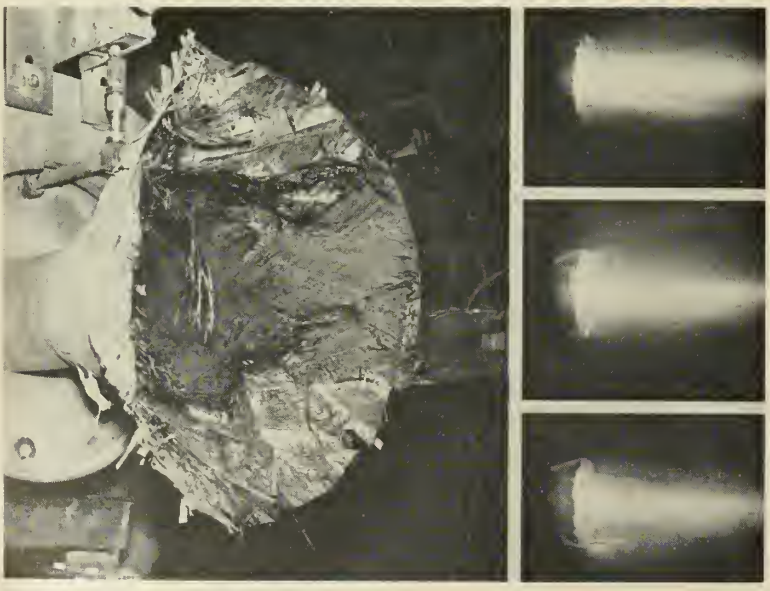
On June 25, 1951, President Truman and Mrs. H. H. Arnold dedicated the Arnold Engineering Development Center. New facilities have since been added, and more are under construction. This emphasis on keeping pace with rapidly developing technology led Arnold in 1958 to modify one, and then three more, engine test chambers to make it possible to test rocket engines under simulated altitude conditions.

Facilities now being built will insure Arnold's technological currency by giving the Center the capability of altitude simulation for spacecraft.

• **Rocket Test Facility**—Designed for development and evaluation testing of propulsion systems for advanced aircraft, missiles and space systems, the Rocket Test Facility can test both solid- and liquid-propellant rockets at simulated altitudes above 100,000 ft.

Full-scale units are put through their paces at normal test altitudes between 110,000-120,000 ft., with some units being tested at 140,000 ft.

Although previously the six test chambers were devoted exclusively to testing air-breathing engines, the emphasis has shifted in the last three years to rockets—evidenced by 761 rocket firings conducted in FY '60 as com-



NOZZLE DETERIORATION under simulated altitude conditions is graphically illustrated. Test—designed to determine performance of a solid-propellant motor—led to development of satisfactory nozzle. Frames at right show progressive deterioration.

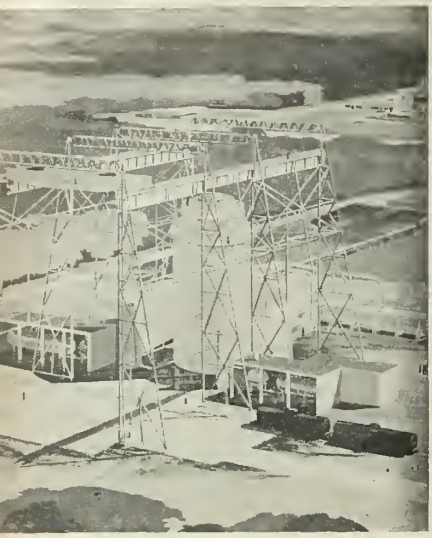


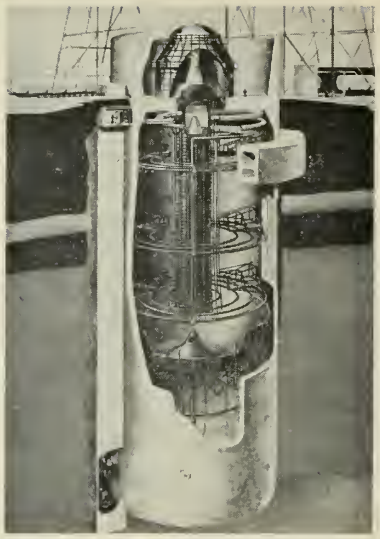
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ARTIST'S CONCEPTIONS of new Rocket Altitude Test Cell, now under construction, show overall facility (left) and cutaway of partly underground test chamber.

pared to 15 rocket tests in FY '58.

Recently, a new test facility—known simply as J-3—was added. This new vertical rocket test stand is the most advanced available in this country and is capable of testing rockets with a thrust capacity of 200,000 lbs. in their normal upright position. Altitudes in excess of 100,000 ft. can be simulated in this chamber. Recently, a full-scale *Titan II* storable-propellant engine was tested in this facility at altitude.

• **Von Karman Gas Dynamics Facility**—The wide range of Mach and Reynolds numbers that can be achieved in its tunnels gives the Von Karman Gas Dynamics Facility a unique aerodynamic testing capability.

Two of the six wind tunnels are intermittent (or blowdown) tunnels, one operating in the Mach-number range from 1.5 to 5 and the other from 5 to 8.

In the blowdown tunnels, compressed air is stored in a pressure tank upsteam from the test section; at the same time, air is evacuated from the chamber downstream from the tunnels. When the test is made, valves are opened at either end of the tunnel and the stored air rushes through the 12-in.-square test section. Test of up to 15 minutes in duration can be conducted in these tunnels.

The second pair of tunnels are continuous-flow facilities. Air is delivered through the test section by a nine-stage, 100,000 hp compressor system. The test sections in these tunnels are 40 in. square in one case and 50 in. in diameter in the other. One of the tunnels, operating from Mach 1.5 to 6, has a flexible nozzle that enables the test engineers to change the airflow during the test; the other tunnel is fixed at a Mach number of 8. A third continuous flow tunnel with an axisymmetric, contoured nozzle and a 50-in. test section will give an airflow of Mach 10.

The third set of tunnels are electric-arc-driven, hypervelocity tunnels called Hotshot 1 and Hotshot 2 with 12- and 50-in. test sections, respectively. Mach numbers in these tunnels range from 15 to 20 and above. Sparked by the discharge of condensers storing millions of joules of energy, the air bursts a thin diaphragm and rushes through the test section almost instantaneously. The extremely short test runs available in the Hotshot tunnels necessitated the development of special instrumentation to permit the recording of a vast amount of data in an extremely short time.

• **Propulsion Wind Tunnel**—Capable of altitude-testing from sea level to well above 100,000 ft. over a Mach number range of 1.5 to 5, the Propulsion Wind Tunnel is designed to test large-model, and in some cases full-scale, aircraft and missiles.

The first of the two large wind tunnels is the transonic circuit operating from Mach 0.5 to 1.5. The other tunnel operates in the supersonic range Mach 1.5 to about Mach 5.

Basically the same in design, the 16-ft. tunnels have removable, interchangeable test sections making it possible to prepare for one test while another test is being run. The test section of both tunnels is porous, to prevent shock-waves—inherent in sonic and supersonic flight—from reflecting off the walls of the chamber and buffeting the model. Operating on a closed circuit system, the tunnels have scavenging systems to remove exhaust gases from the tunnel when operating propulsion systems are tested.

• **Computer speeds operations**—An IBM 7070 computer—installed at the Arnold Center last October—has greatly augmented the center's capabilities. Prior to the 7070 installation, it took two to three days to reduce data from rocket firings. More complicated tests such as heat transfer studies were either impossible to process or took as long as two to three weeks. In contrast, the IBM solid-state computer can furnish complete test results in less than an hour—for a relatively simple rocket firing or even the more complicated tests in the Hotshot tunnels. The amount of time necessary to process and reduce the data depends more on the other work scheduled for the computer than on the test data itself.

An "off-line" operation, the computer receives its data inputs from the paper-tape ERA 1102's which have been operating at the Center since 1955. This data is put onto magnetic tape and reduced through a simplified programming language known as Fortran (for formula translation). A scientific computer language, Fortran provides the Arnold scientists and engineers with a symbolic coding system closely resembling the language of mathematics.

In addition to reducing test data, the 7070 is used for payroll and cost distribution and soon will be keeping records of material costs and inventory control at the Center.

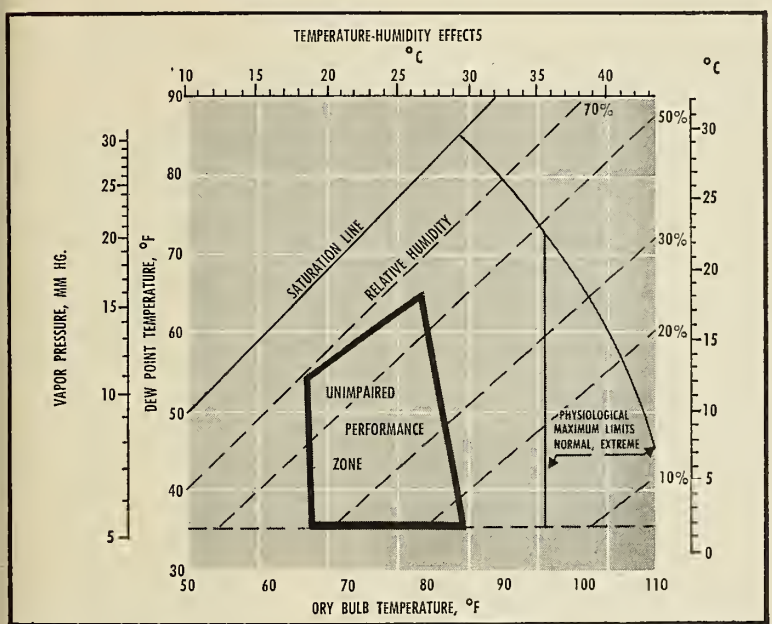
One enthusiastic scientist at Arnold said that the choice is no longer between slowing down the test or missing some data. Now, with the advent of the high-speed computer, they are able to monitor all the data channels at once. In his opinion, the 7070 has already become a necessity for the efficient conduct of some of Arnold's test programs.

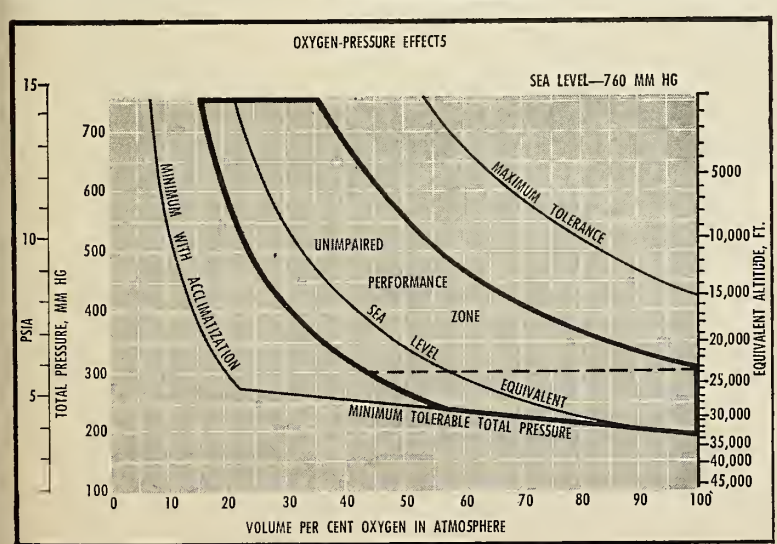
• **Future test facilities**—The Arnold Center has under construction two new facilities. The first, a new Vertical Rocket Test Cell, will initially be able to handle rocket engines producing a thrust of 500,000 lbs. at simulated altitudes in excess of 100,000 ft. Its construction is expected to be completed in late 1962 or early 1963 at a cost of $11 million. The vertical facility will have a length of 250 ft.—most of it underground, with only the final 100 ft. rising above the surface of the earth—and a diameter of 100 ft. It will be capable of housing complete missiles in an upright position, and eventually will be able to handle thrusts up to 1.5 million lbs.

The second major facility is the 1000-ft. hyperballistic range, 10 ft. in diameter, in which a two-pound projectile can be accelerated to 20,000 ft. per second. Although construction has begun, it will be two years before it is completed. ⁂

Charts Show What Man Can Endure in Space

Garrett Corp. graphically presents limits of conditions under which astronaut can function





TOLERANCE CONDITIONS for a man living continuously in a space vehicle have been reduced to composite charts by The Garrett Corp.

The information is the latest compilation of results in the environmental control field and reflects some of the studies performed by the firm in its *Apollo* experiments.

One chart, an oxygen-pressure table, shows the physiological effects of oxygen in the atmosphere of a space vehicle and the total pressure of that atmosphere. The second chart presents the physiological effects of dry-bulb temperature and the humidity of the atmosphere in a space vehicle.

Three main areas of physiological performance are defined by the oxygen chart—a minimum acclimatization zone, an unimpaired performance zone and a maximum tolerance zone.

The unimpaired performance zone indicates that range which can be tolerated indefinitely without performance decrement. This range is very similar to atmospheric air at sea level containing 21% O_2 by volume and leading to a blood saturation of 95%. To maintain the same degree of oxygen in the blood at lower pressures, the oxygen amount must increase.

The minimum zone is based on the effective partial pressure of O_2, disregarding aeroembolism which may occur below 300 mm Hg total pressure in the absence of adequate denitrogenation. This aeroembolism limitation is indicated by the interrupted horizontal line on the chart.

The maximum tolerance zone requires acclimatization—considered to be a continuous exposure to conditions of successively lower pressure, with no intermediate return to higher pressure.

• **"Shirt sleeves"**—The second graph —temperature humidity—describes an unimpaired performance zone commonly referred to as a "shirt-sleeve" atmosphere. The limits of this zone are: a dew point of 35°F, below which excessive drying of the respiratory system takes place; a relative humidity of about 70%, above which skin and clothes are uncomfortable; a dry-bulb temperature of 65°F, below which extra clothing is required; and dry-bulb temperature of 80 to 85°F, depending on dew point.

At points to the right of the unimpaired performance zone, appreciable perspiration will occur as the body seeks to maintain a heat balance. At the normal limit, the perspiration rate will be one pint per hour. The extreme rate is one quart per hour, and many individuals cannot adjust to this.

The charts were developed by F. H. Green of Garrett's AiResearch Manufacturing Div., in cooperation with Dr. J. Waggoner, also of AiResearch, and Dr. U. Luft of Lovelace Foundation. ❖

Monsanto High Heat Resins for space age applications

Monsanto Resinox high heat resistant resins were developed to withstand elevated temperature exposures. Now being used in missile and rocket components, laminates made with Resinox Resins have high strength-to-weight ratio, low rate of ablation, excellent shock resistance, low thermal conductivity, and stability at extreme temperatures.

Monsanto High Heat Resins include:

Resinox SC-1008—Phenolic Laminating Varnish. Designed for applications requiring extended exposure at temperatures to 500°F and very short term exposure in the 5000°F temperature range. Offers good ablation resistance.

Resinox SC-1013—Silane Modified Phenolic Varnish. For applications demanding extended exposure in the 500°F to 600°F range, and very short term exposure above 5000°F. Offers superior high frequency electrical properties.

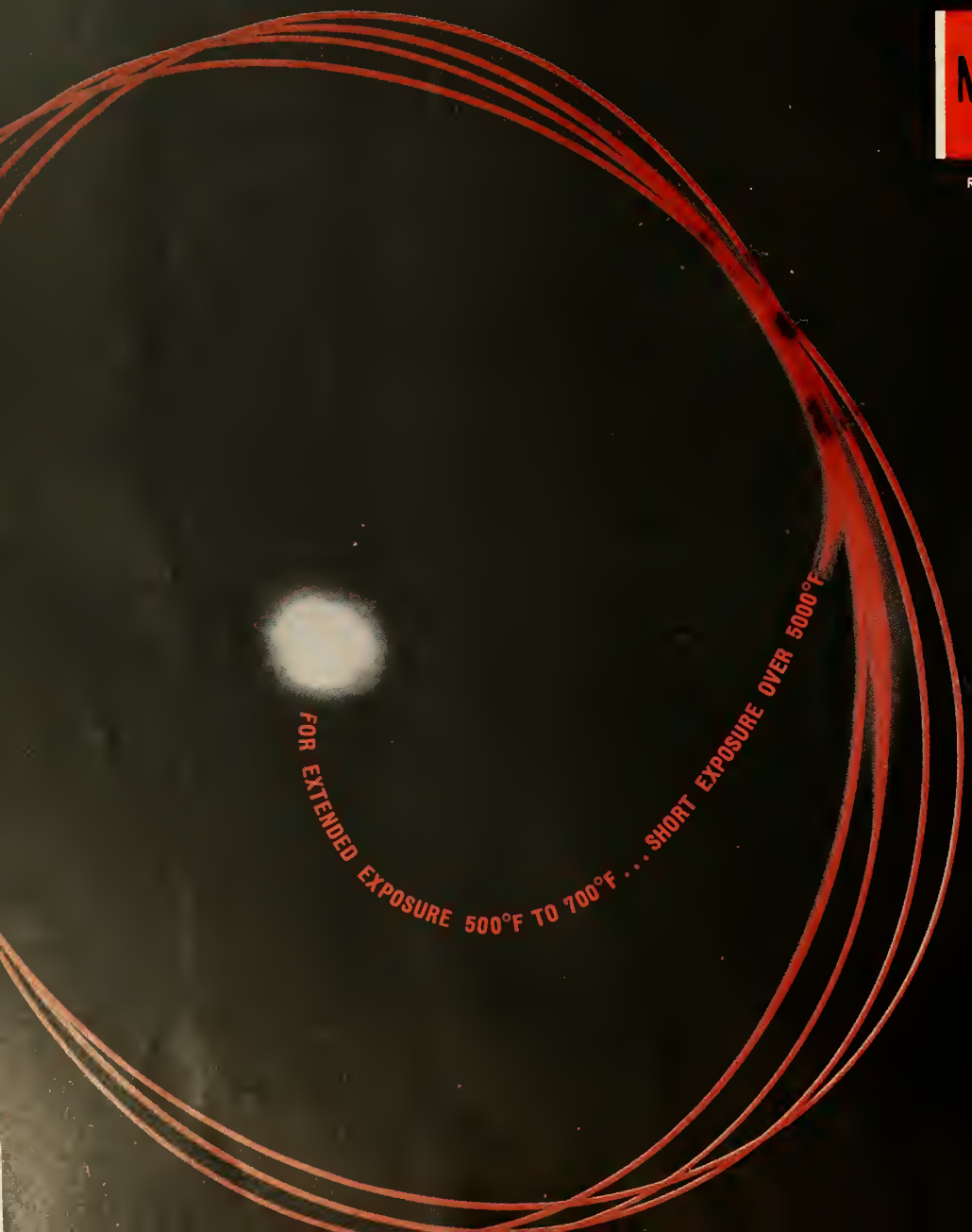
Resinox TS-5946—Elastomer Modified Phenolic Varnish. Recommended for blending with high temperature phenolic resins to increase tack for ease of layup, and increase flexibility and resilience of final laminate.

Resinox RI-4080—Modified Phenolic Resin Compound. Modified phenolic resin designed for use in moldings which must have short-term heat resistance to temperatures of 2000°F or higher.

Resinox RI-4009—Phenolic Resin Compound. Developed for use with glass and asbestos filter materials. It can be used in dry powdered form or as a varnish when dissolved in alcohol. For more information, write for a copy of "High Temperature Resistant Resins Folder" to Monsanto Chemical Company, Plastics Division, Room 828, Springfield 2, Massachusetts.

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Prospector Getting Hard Second Look

by Hal Taylor

THE STEPPED-UP time schedule for Project *Apollo* is forcing changes in the U.S. lunar exploration program —including the possibility that the *Prospector* spacecraft series may be dropped or modified.

NASA officials reveal that various lunar design study contracts worth about $2 million will be awarded in the next couple of months.

However, the big question of whether to proceed with *Prospector* at a cost of hundreds of millions of dollars will not be decided until next year.

Besides its huge costs, other factors forcing the space agency to take a second look at the program include:

—Under its present schedule (1966-1967), the first *Prospectors* will be launched at just about the same time as U.S. astronauts are scheduled to be orbiting and landing on the moon.

—The complexity of the spacecraft, plus the difficulty of soft-landing it on the moon, make its chances of success questionable at that date. Also its value. It may be possible to accomplish most *Prospector* experiments on the first- and second-generation lunar spacecraft—*Ranger* and *Surveyor*.

While it is likely that some form of *Prospector* will get the go-ahead, big changes are almost certain to be made in its configuration and its mission. The same sort of changes are already in the works for *Ranger* and *Surveyor*.

• **More launches**—The number of *Ranger* launches—designed for an eventual hard landing on the moon—has been increased from five to perhaps 10.

Surveyor—the lunar soft-landing vehicle—will have a modified B version which will make orbital reconnaissance missions to the moon's surface in late 1964. Originally scheduled for seven launchings, its total will probably be increased.

Prospector's problems stem directly from President Kennedy's order for a step-up in the U.S. effort to get a man to the moon and back. It was first scheduled for 1970, but NASA now has hopes of accomplishing that mission as early as 1967. By 1965, the space agency hopes to orbit the moon with a manned *Apollo* spacecraft.

Prospector was first envisaged as a tool to carry on the lunar experimentation begun by *Ranger* and *Surveyor*. Later, its concept was changed to include its utilization as a support mission for a manned lunar landing.

Under that plan, *Prospector* would land thousands of pounds of useful payload at a predetermined point on the moon's surface. Before the landing of men, it could establish a small depot of supplies and equipment, possibly including a "jeep" for surface transportation and small rockets to return selected surface samples to earth.

An instrumented version could provide a detailed site survey prior to manned landing. It could also provide man with a small radiation shelter to protect him from solar storms.

• **Part of Apollo**—But the job of returning surface samples to earth could be better handled by men.

In addition, more advanced versions of the *Apollo* spacecraft will probably be able to carry their own support equipment to the moon. There is also the possibility that if *Prospector* is primarily designed to support a manned landing, it might better be placed under the management of Project *Apollo* and integrated into its operations.

NASA officials are quick to point out that the whole *Prospector* program is now under detailed study within the agency and final decisions on it will depend upon the progress of the *Apollo* effort and the success of its predecessors, *Ranger* and *Surveyor*.

Ranger I was scheduled for launch early this month, but a whole series of technical problems forced a postponement until late August or early September.

Meanwhile, the space agency took another step in its speed-up of the *Apollo* program as it announced that the Massachusetts Institute of Technology had been awarded a design contract to develop several guidance systems for the spacecraft.

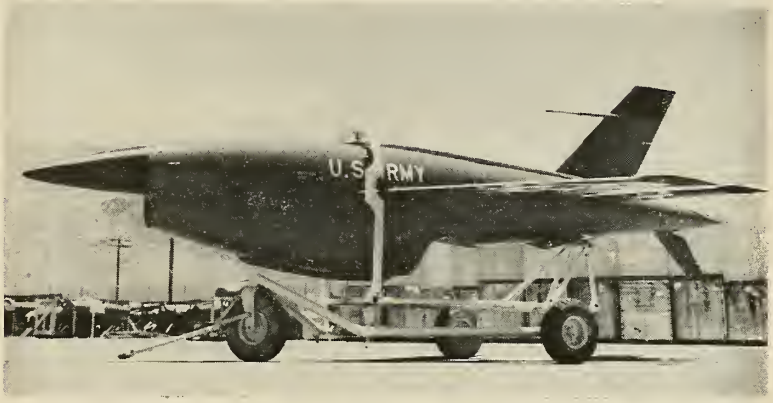
MIT's Instrumentation Laboratory has been working on a design study of the *Apollo* spacecraft guidance and navigation system for the past seven months.

Under the contract, the MIT group will design and build the first several systems. Later, a contractor will be chosen to manufacture the systems.

The laboratory is the oldest member of the *Apollo* contractor team. The early selection of the guidance-navigation system contractor was required because the guidance system development is basic to the overall *Apollo* mission.

The instrumentation laboratory is a non-profit organization employing about 1200 employees. It is headed by Dr. C. Stark Draper, often called the "father of inertial guidance."

In addition to the on-board guidance and navigation system, the laboratory will also develop required ground support and checkout equipment. A contract covering the first year's effort, to cost an estimated $4 million, will be signed shortly. ⌘



New Target—Ryan's Firebee 124-E

DELIVERY OF FIREBEE 124-E jet target drones is now being made to White Sands for surface-to-air missile training. New model is special configuration of Ryan Q-2C.

←— Circle No. 5 on Subscriber Service Card

Guidance Adequate for Soft-Landing

STL scientists present detailed analysis showing that philosophy is equal to need but sensors are lacking

by Charles D. LaFond

STANFORD, CALIF.—The only limiting factor in achieving soft lunar landing velocities of less than 20 feet per second is the state of the art of sensors.

If sensor accuracy can be improved (or if those employed prove to be better than is currently assumed) velocities of less than 10 ft. per second are possible.

Under a recent subcontract to the Jet Propulsion Laboratory, scientists at Space Technology Laboratories, Inc., have completed a paper study of a terminal guidance system for such a landing.

Results of this study were presented here last week at Stanford University during the First National Guidance, Control and Navigation Conference, sponsored by The American Rocket Society.

In their paper, R. K. Cheng and I. Pfeffer of STL presented a detailed analysis of a practical landing scheme. The guidance plan involves the use of a spacecraft boosted into a transit trajectory to the moon.

Midcourse correction, determined by earth-based radio tracking facilities, controls the landing to a predesignated impact area within reasonable tolerances.

A landing velocity of approximately 20 ft. per second, the authors said, will permit safe landing of even sensitive scientific instruments.

• **Meeting jammed**—This first nationwide assembly of G&C experts exceeded all expectations in attendance. Planning for from 350-400 registrants, the conference found itself swamped the first day with over 700 attendees and more arriving each day thereafter for the three-day meeting.

That a general conference for this field was long overdue actually was indicated several months ago when the first call for papers was issued. Over 140 were submitted for presentation at the 15 technical sessions; from among these, committee chairmen selected 75. Evening sessions were required in order to accommodate all of these.

Principal speakers at the three luncheons and banquet were Dr. C. Stark Draper, MIT; Dr. Helmut Schlitt, Bell Aerosystems Co.; Dr. L. D. Schiff, Stanford University; and J. R. Moore, President of Autonetics Division of North American Aviation.

Reflecting the mood of the majority of conferees, Draper asserted that guidance and control will never be a limiting factor in any future U.S. space effort. When the rest of the technology is ready for another step forward, he declared, it will find G&C ready and waiting.

• **Lunar landing detailed** — Coast altitude and spacecraft orientation, said Cheng and Pfeffer, would be maintained by a cold gas altitude control system. It would hold the vehicle in proper thrust direction for midcourse correction. Control both in thrust and altitude would be accomplished by three liquid-propellant vernier engines.

Nearing the moon at a closure rate of over 8000 ft. per second, the vehicle would be orientated by earth command to proper direction for retrothrust application. Sun-and-star or Sun-and-Earth tracking sensors would provide basic attitude reference.

Terminal deceleration phase starts at about 50 nautical miles altitude above the moon. Ground command orientation of the vehicle would be such that the thrust axis is nearly parallel to the approach velocity vector.

At an altitude of roughly 40 nautical miles above the lunar surface (determined by radar altimeter), a main solid-propellant engine would be ignited for retrothrust, slowing the craft to a relative velocity of 660 ft. per second, the authors said.

Guidance with respect to altitude velocity profile would not be employed during main engine retrothrust. Accurate measurements by the terminal sensors would be difficult during the phase because of high altitude, large flame effects, and vibration.

Instead, the authors pointed out, system design would accommodate probable tolerances in engine burnout altitude and velocity.

Burnout would occur at about 6 nautical miles, followed shortly by engine jettison. The verniers would provide terminal retrothrust for the soft landing. Body-mounted Doppler radar sensors would supply altitude and velocity data during the phase of flight.

The vernier engine thrust level at 10 feet altitude would be reduced to that which would provide a new thrust acceleration of one lunar-g. The craft would descend at constant velocity of 10 ft. per second; lateral guidance would be terminated.

The system must be able to remove an initial lateral velocity error of at least 100 ft. per sec. Lateral landing velocity, the authors said, must not exceed 10 ft. per sec.

At 30 feet the verniers are shut off and the craft free-falls to the lunar surface, impacting at a rate of 20 ft. per sec. A three-legged landing gear would absorb residual energy at landing to limit shock effects on the craft and its scientific instruments.

• **Instrumentation required**—Basic subsystems required for the terminal guidance system include an altimeter, communications antenna, three Doppler radar sensors and antennas, an altitude control system, an accelerometer, and control computer.

Slant range from the altimeter, range rates from the Doppler radars, and thrust acceleration data from the longitudinal accelerometer are fed to the computer.

The computer then determines slant range along the thrust axis to the lunar surface, vehicle velocities along the roll pitch, and yaw axis and thrust acceleration. The computer then commands thrust acceleration and pitch and yaw rates for guidance correction.

The computer also directs gimbal-angle steering corrections for a high-gain communications antenna to maintain an Earth fix despite vehicle maneuvering during the vernier solo phase.

All the necessary equations to perform the lunar landing guidance and control functions have been worked out, the scientists said. Detailed error analysis, based on anticipated tolerances of actual hardware indicate the following:

1) Vertical velocity error is due primarily to an assumed error of plus or minus 10 ft. (3-Sigma) in the altimeter reading at vernier engine shut-off.

2) Horizontal velocity error is due almost totally to an assumed random bias error of 3 ft. per second (3-Sigma) in each Doppler radar beam. ⌗

RADIO CORPORATION OF AMERICA began construction of a 175,000-sq.-ft. addition to its Burlington, Mass., plant. RCA's Aerospace Communications and Controls Div. will occupy the new wing, scheduled for completion in early 1962. Included will be a 30-ft.-high bay area suitable for missile assembly.

W. L. GORE & ASSOC., INC., fluorocarbon processing facilities have been more than doubled by plant expansion of the Newark, Del. firm. The addition will provide for new technology being developed by Gore in the field of fluorocarbon polymers, especially polytetrafluoroethylene.

DYNALECTRON CORP.'s Land-Air, Inc. subsidiary has established a new division at Santa Barbara. The new Paradyn Division will provide computing, mathematical and general technical services to defense agencies and industrial firms engaged in research and development. The staff will be composed mainly of mathematicians, with a high proportion of Ph.D.'s.

ASTEK INSTRUMENT CORP., Armonk, N.Y., has been formed to design and manufacture precision flight and engine instruments for advanced aircraft and missiles. Already designed is a fully automatic cabin-pressure control system for use in space vehicles and high-altitude aircraft.

FORD MOTOR CO. Defense Products Group established a Los Angeles office responsible for liaison with the Air Force Systems Command's Space Systems and Ballistic Systems Div., and other functions. The office will represent both Aeronutronic Division and the Special Military Vehicles Operations.

LORAL ELECTRONICS CORP. acquired the American Beryllium Corp., Inc. and its subsidiary companies, United States Beryllium Corp. and Visioneering Corp. American Beryllium and United States Beryllium constitute the largest independent beryllium-fabricating operation in the country. The acquisition will be operated as a wholly owned subsidiary of Loral.

GEOSCIENCE, LTD., has been formed in San Diego to do scientific research and development work. The firm's president, Dr. H. F. Poppendiek, said contracts for research in ballistic missile defense, nuclear power systems, new space propulsion concepts, and atmospheric physics have already been received.

HEWLETT-PACKARD CO. and the Sanborn Co. have merged through exchange of stock. The merger becomes effective Aug. 31, with Sanborn continuing as a separate corporation. Sanborn stockholders will receive 1.4 shares of common and 1 share of preferred H-P stock for each share held.

Financial Reports

COMPANY	PERIOD	INCOME		EARNINGS	
		1961	1960	1961	1960
Aerojet-General	6 mo. May 31	$238,058,005	$200,511,325	$ 5,995,850	$ 4,456,556
Amphenol-Borg	6 mo. June 30	34,641,054	35,226,005	463,470	1,532,948
Atlas Chemical	6 mo. June 30	40,284,000	40,178,000	2,204,000	2,369,000
Burnell & Co.	Year, Mar. 31	3,505,567	3,223,303	134,178	122,092
Celanese Corp. of America	6 mo. June 30	133,515,997	137,453,943	8,621,439	10,054,290
Cohu Electronics	6 mo. June 30	5,417,204	3,211,945	404,341	13,632
Dynamics Corp. of America	6 mo. June 30	22,226,614	20,675,146	881,840	870,926
Electronic Associates	6 mo. June 30	8,631,000	6,485,000	404,000	435,000
Hagan Chemical & Controls	6 mo. June 30	20,034,463	20,035,595	820,909	901,822
Hallicrafters Co.	Quarter May 31	13,641,000	6,751,000	362,000	140,000
	9 mo. May 31	41,893,000	21,872,000	1,125,000	650,000
IMC Magnetics Corp.	Year Feb. 28	4,622,061	4,085,251	—74,955	25,841
Loral Electronics	Year Mar. 31	35,776,964	17,439,871	1,301,618	579,216
Martin Co.	6 mo. June 30	414,233,246	302,758,898	13,538,418	7,647,710
Motorola Inc.	6 mo. June 30	128,722,224	145,725,874	3,062,529	6,506,218
Vitro Corp. of America	6 mo. June 30	23,323,716	30,480,351	978,365	546,398
Xerox Corp.	6 mo. June 30	25,835,049	16,621,081	1,993,038	1,066,111

S-3 Satellite

(Continued from page 16)

—To measure particle fluxes, types and energy as a function of direction, time and position, in and around the Van Allen radiation belts. The detector is most sensitive to the low-energy particles which have not been directly measured to date and yet have been indicated to be in the inner and outer radiation belts.

—Solar Cell experiment—To measure the effects of the deterioration of solar cells caused by direct exposure to the radiation in the Van Allen belts. It consists of four strips of silicon solar cells, with 10 cells per strip, mounted on the surface of the spacecraft. One strip of 10 cells is unprotected, while the remaining three strips are protected by 3-, 20-, and 60-mil-thick glass, respectively. During the life of the spacecraft, it will be possible to compare the effectiveness of the glass filters in preventing degradation of the solar cells due to radiation.

• **Milestone** — Space Agency officials said that the *S-3* represents a milestone in engineering design with its capability of accommodating 10 particle-detecting systems and associated electronics, all in a usable volume area of 1.578 cu. ft.

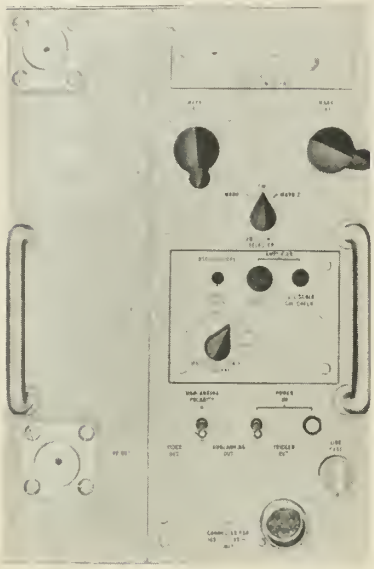
An octagon-walled platform, fabricated from nylon honeycomb and fibreglass with an aluminum cover .020-in. thick, houses most of the electronics and instruments. Height of the octagon is 5½ in. It is slightly more than 26 in. across the flats of the octagon. A transmitter is located in the base of the payload, allowing heat to dissipate through the structure and aluminum cover.

The satellite will be launched with a *Delta* booster at an inclination angle of 33 degrees from the Equator. Due to the highly eccentric orbit and small power of its transmitter, it will be one to two weeks before an accurate orbit can be determined. Since the orbital period is 31 hours, almost a day may pass before an orbit can be confirmed.

S-3 will be followed by project *S-64*. That satellite will carry equipment to measure the particle fluxes, types and energies in the outer edge of the outer Van Allen Radiation belt as functions of position, direction and time.

It will also study long period variations in the primary cosmic ray intensity.

Several particle detector systems, an optical aspect sensor, and a magnetometer for aspect and field measurement will be carried by the spacecraft and placed in a 24-hour orbit at an altitude of 22,300 statute miles. ✠



Incremental Power Spectrum Analyzer

An Incremental Power Spectrum Analyzer, developed to provide direct reading measurements of RF power and frequency with laboratory accuracy under operational conditions for stationary, mobile, airborne or shipboard application is available from Hallicrafters. Using sampling techniques, this instrument provides a continuous display of microwave signal power distribution with an accuracy formerly obtainable only with point-to-point measurements. The first model of the incremental power spectrum analyzer offered commercially covers the S-band spectrum from 2400 to 3650 megacycles each. For complete coverage of the band, the 10-mc/s channels overlap at the half-power (3db) points.

Circle No. 225 on Subscriber Service Card

Recording Amplifiers

Miniaturized, encapsulated d-c recording amplifiers and chopper oscillators for carrier-erase airborne tape recorder systems are available from Westrex Recording Equipment. The RA-1665 amplifier consists of an input chopper-modulator, a stabilized band-pass amplifier and an output chopper demodulator. A RA-1666 chopper oscillator supplies the high-frequency, square-wave signals for up to 13 amplifiers. Each all-solid-state module is about three cubic inches in volume. Both have been successfully operated during 600-g shocks with a time duration of 10 milliseconds. The modules can be encapsulated in polyurethane or epoxy resin. Performance characteristics in severe environments are outstanding.

Circle No. 226 on Subscriber Service Card

Slip Rings

Slip Ring Company of America is marketing a line of slip rings specifically designed for space and space environment applications. These assemblies are available with up to several hundred circuits. They are characterized by extremely low noise to signal ratios, enabling transmission of minute signals with accuracy and without distortion.

Circle No. 227 on Subscriber Service Card

Portable Strain Indicator

A portable strain indicator providing digital readout and twice the gage factor range previously provided is available from Electronics & Instrumentation Division of Baldwin-Lima-Hamilton Corp. Designated the Type 20, the new indicator represents a significant improvement over the Type N unit and provides digital readout and doubled gage factor range. The indicator is designed to give simple, fast, dependable operation with most commercially available strain gages in one-,

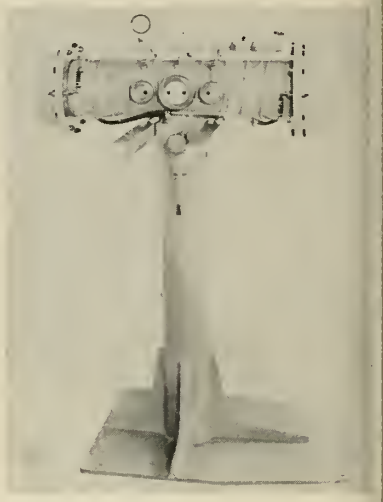


two- or four-arm networks, and with strain gage transducers, bonded or unbonded, to provide direct indication of the measured variable.

Circle No. 228 on Subscriber Service Card

High Temperature Furnace

A reliable graphite tube furnace for achieving uniform high temperatures over a relatively large volume is available from Temptron, Inc. Designated



Model 2210, the furnace is a research tool useful for expansion measurements at elevated temperatures. The furnace is capable of operation to 5500°F. The heating element, a graphite tube 1½ in. in diameter and 30 in. long, operates in an inert atmosphere. The uniformly heated zone extends over the center ten inches of the tube with variations in temperatures of less than 100°F from the average.

Circle No. 229 on Subscriber Service Card

Low Speed Perforator

A low speed tape perforator offering extremely rugged reliability has been developed by Soroban Engineering, Inc. Designated as Model LP-2, the perforator operates at punching speeds up to 120 codes per second. Many of the design feature used in Soroban's GP-2 super-speed tape perforator are similar to those used in the LP-2. These include feeding mechanism, punch and die assemblies, magnets. In the LP-2, the reluctance pickup is mounted internally to the punch and eliminates field adjustment. All other adjustments are made at the factory, including air gap between the pickup and the timing disc.

Circle No. 230 on Subscriber Service Card

S-band Parametric Amplifier

The Motorola Solid State Electronics Department has available a high-gain, low-noise parametric amplifier designed for operation at 2480 mc—2520 mc in S-band. Outstanding characteristic of the new device is a design permitting universal application of the basic amplifier as: a broadband parametric amplifier, a narrowband parametric amplifier, or as a parametric up-converter with output at X-band. Designated

Model SPA01, the Motorola device utilizes a single, silicon p-n junction diode as the variable-capacitance energy storage element, a miniature ferrite circulator for input-output signal separation, and filters at the input and idler circuits to permit extremely wideband operations.

Circle No. 231 on Subscriber Service Card

Silicon Power Rectifiers

The Semiconductor Division of Hughes Aircraft Co. is marketing its "Golden Line" of silicon power rectifiers. Electrically they feature an extremely low reverse leakage of less than one microamp at rated voltage at room temperature. Typical units have a forward voltage drop of less than one volt and a dynamic impedance as low as 0.0035 ohms at rated current. Surge currents of up to 240 amps can be safely applied on the 12 amp units for one cycle at 60 cps and the same amperage can be obtained with the reverse polarity units. Production quantities of the 6 and 12 amp units can be supplied in quantity in the 600-1000 volt ranges.

Circle No. 232 on Subscriber Service Card

Crimping Tool

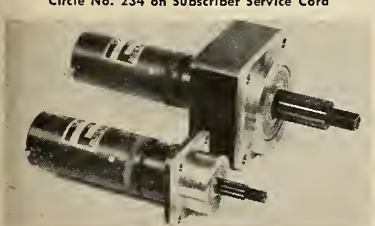
A crimping tool for making fast, reliable connections between wires and terminals in electronic production is available from Pacific Coast Electronics Corp. The tool, especially designed for use with Pacific Coast's Tri-El terminals, when hand-operated by the average assembler, is capable of production rates in excess of 700 connections per hour. The combined use of the tool and the Tri-El terminal enables an operator to fabricate circuits at 250% higher rates than with other types of terminals.

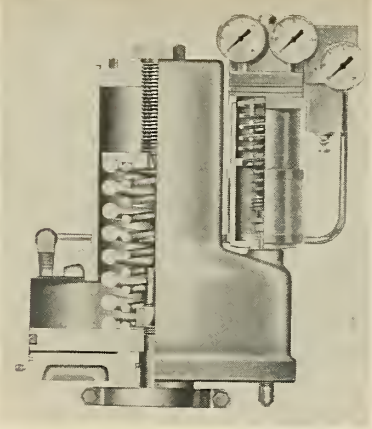
Circle No. 233 on Subscriber Service Card

Planetary Gearmotors

A planetary gearing system for use with 1½-in. precision motors provides up to 500 in.-lbs. of torque at 8 rpm continuous duty and up to 1000 in.-lbs. of torque for intermittent use is available from Globe Industries, Inc. Ball bearings are used at all bearing locations to provide stage efficiencies of 95% or better, and gearbox rating is 1/10 hp. System offers a choice of 18 reduction ratios from 1.87:1 to 941:1 in the smaller design.

Circle No. 234 on Subscriber Service Card





Precise Pneumatic Actuators

Security Valve Company is marketing Series P Pneumatic Positioning Actuators designed for signal pressures in the 3 to 15 PSIG range or as required. With air-to-open action, the flow thru the valve body is normally directed in over the valve plug while in the air-to-close action, the flow is normally directed in under the valve plug. The new actuator has a position accuracy of 0.1% of the stroke. The positioner is completely adjustable from the outside which eliminates the normal time-consuming cut and try starting air and span adjustment associated with many existing designs.

Circle No. 235 on Subscriber Service Card

Ferrite Core Memory

The RQA, an addition to the line of "R" series ferrite memories, is available from Ampex Computer Products Co. The RQA has a 5 microsecond memory cycle with an access time of 2.0 microseconds and a buffer cycle of 2.5 microseconds. Standard word capacities are 1024, 2048, 4096, 8192, 16,384, and 32,768 available in 8 to 60 bit word lengths. Standard operating modes are random access with clear-write, read-regenerate cycles or load and unload half cycles. Available as an option—sequential-access.

Circle No. 236 on Subscriber Service Card

Welding Controller

An automated arc welding controller is available from Automation Development Corp. Designated Model 408A, this controller solves automatically the problem of accurately positioning the electrodes of an arc welder in order to maintain constant voltage drop across the material being welded. By means of this device, which utilizes the company's standard step-servo motors and controllers, high quality welds can be consistently and automatically produced under the most difficult and exacting conditions. The usual problems of inadvertent burning of electrodes or production of "weak joints" are practically eliminated.

Circle No. 237 on Subscriber Service Card

Asbestos-base Plastics

Two new reinforced plastics made with asbestos base and proprietary phenolic resins have been added to their line of Tayloron high temperature materials by Taylor Fibre Co. The materials are designated as Tayloron PA and Tayloron PA-6. They were developed specifically for use in rocket components and other high temperature applications. Tayloron PA has the best machining properties of all asbestos-base grades of reinforced plastics. It is also characterized by excellent thermal insulation, heat resistance, good ablation performance in a wide temperature range, high tensile and flexural strength and good impact resistance.

Circle No. 238 on Subscriber Service Card

Direct-Reading Wavemeter

A data-dial direct-reading wavemeter providing high accuracy of direct frequency readout over the entire range of the instrument without requiring correction tables or charts to compensate



for residual non-linearity is available from General Communication Co. The frequency scale is a lightly sloping line on a long tape, which moves behind a window on which a curved index line is drawn. As the cavity is turned through its range, the intersection of these two curves shifts by exactly the amount needed to offset residual variations over the band covered, giving frequency at any setting without further correction.

Circle No. 239 on Subscriber Service Card

Digital Readout Assembly

An assembly of digital readouts featuring quick-disconnect and plug-in is available from Industrial Electronic Engineers, Inc. Called the Series 20000P Digital Readout, it offers the advantages of dual front and rear maintenance. The entire assembly, which is sub-panel mounted, may be easily removed from the master panel by use of the four large captive thumb screws conveniently located at the front of the assembly.

Circle No. 240 on Subscriber Service Card

NASA

$300,000—**Martin Co., Denver; Lockheed Aircraft Corp.; General Dynamics/Astronautics; Douglas Aircraft Co.,** individual 6-mo. contracts to study vehicle preliminary design problems involved in flight-testing a nuclear rocket engine in an upper stage on a *Saturn* booster. (4 contracts—$75,000 ea.)

$95,000—**The Marquardt Corp.,** Van Nuys, Calif., from Langley Research Center, for facility equipment to boost the Center's structural wind-tunnel testing temperature from 600°F to maximum of 2000°F.

MISCELLANEOUS

$1,315,000—**Avien, Inc.,** Woodside, N.Y., from AF and Navy, for equipment and instruments for missiles, aircraft, undersea and industrial uses.

$1,000,000—**General Electric's Ordnance Dept.,** Pittsfield, Mass., from **Tidewater Keiwit-P.E.C.,** for aiming reference system for the 600-ft. radio telescope being installed at Sugar Grove, W. Va.

Telecomputing Corp., Los Angeles, from **Lockheed Aircraft Corp.,** for satellite launching equipment. No amount disclosed.

Fleming Industries, Inc., Torrance, Calif., from **Rocketdyne Div. of North American Aviation,** for electronic initiator units for the *Saturn* space vehicle program. Amount not disclosed.

General Precision/Librascope, Glendale, Calif., from Calif. Institute of Technology Jet Propulsion Laboratory, for investigation of future data-processing needs in space and planetary probes. No amount disclosed.

NAVY

$1,900,000—**Transducer Div., Consolidated Electrodynamics Corp.,** from BuWeps, for manufacture of pressure detectors, hydrophones, and depth compensators.

$1,500,000—**Goodyear Aircraft Corp.,** Akron, Ohio, for production of *Asroc* missile-launched depth charges.

Hamilton Standard Div., United Aircraft Corp., from **Boeing Co.,** for automatic stabilization equipment for first hydrofoil antisubmarine patrol boat. No amount disclosed.

Bendix-Pacific Div., The Bendix Corp., North Hollywood, Calif., from Bureau of Ships, for five automatic maneuvering control systems for *Polaris*-firing atomic submarines. No amount disclosed.

ARMY

$10,485,000—**Bendix Corp., Eclipse Pioneer Div.,** Teterboro, N.J., for *Pershing* missile components and engineering services.

AIR FORCE

$16,000,000—**Graver Tank & Mfg. Co., Div. of Union Tank Car Co.,** Chicago, from **The Fluor Corp.,** for fabrication and erection of steel plate work for 18 *Titan* launch silos at Davis Monthan AFB.

$15,381,250—**General Electric's Light Military Electronics Dept.,** Utica, N.Y., from **Nortronics,** for development of missile guidance computer for *Skybolt*.

$6,000,000—**North American Aviation, Inc.,** Los Angeles, for *GAM-83 Bullpup* kits and launchers.

$3,000,000—**Hallicrafters Co.,** Chicago, for classified airborne electronic warfare penetration systems.

$2,898,600—**Douglas Aircraft Co.,** Cape Canaveral, for launch support of space programs.

$1,704,000—**Electronic Communications, Inc.,** St. Petersburg, Fla., from **Burroughs Corp.,** for production and delivery of airborne maintenance spare communications and data link equipments for use in ALRI-SAGE early warning aircraft; ground equipment installation, etc.

$1,651,000—**Radiation, Inc.,** Palo Alto, Calif., for high-output transmitters and power supplies for the space probing "Haystack" antenna system.

$635,618—**Reeves Instrument Corp., subsidiary of Dynamics Corp. of America,** New York City, for maintenance and logistic support supply services for Strategic Air Command's radar bomb-scoring system.

$200,000—**Commercial Sales Div., American Bosch Arma Corp.,** Garden City, N.Y., for hydraulic accumulators for installation at hard sites of *Titan II* (Phase HS-1).

$200,000—**Electronics Div., Arnoux Corp.,** Los Angeles, for decommutation ground stations for Atlantic Missile Range.

$193,000—**Temco Electronics Div. of Ling-Temco Electronics, Inc.,** Dallas, from Rome Air Materiel Area, for production of video correlators for ground-based height-finder FPS-6 radars.

$113,528—**National Research Corp.,** Cambridge, Mass., for studies and experiments on effects of ultraviolet radiation on space vehicles.

$100,000—**Clauser Technology Corp.,** Torrance, Calif., for study of cryovapor pumping techniques and the building and testing of a scale model of a space simulation chamber.

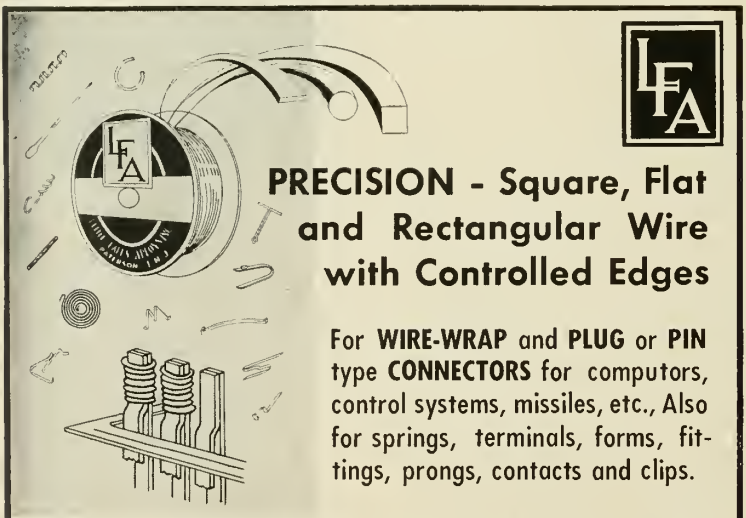
$80,000—**Computer Equipment Corp.,** Los Angeles, from Missile Development Center, Holloman AFB, for development and production of system for use in measuring speeds on supersonic test sled track and production of digital readout devices and circuit elements (2 contracts).

REQUESTS

Space Task Group, Procurement and Supply Office, has issued an RFP 9-150 for Project *Apollo* spacecraft. Proposals are due to be received at the National Aeronautics and Space Administration-Space Task Group, Procurement and Supply Office, Langley Field, Va. by Oct. 9, 1961. The following firms have been invited to participate:

The Boeing Co., Aerospace Div., P. O. Box 3707, Seattle 24, Wash., Attn: L. A. Wood—Chance Vought Corp., Vought Astronautics Div., P. O. Box 5907, Dallas 22, Tex., Attn: J. Russel Clark, Subsequent to Sept. 1, 1961, Chance Vought Corp., subsidiary of Ling-Temco Vought, Inc., Vought Astronautics Div., P. O. Box 5907, Dallas, Tex.—Douglas Aircraft Co., Inc., 3000 Ocean Park Blvd., Santa Monica, Calif., Attn: C. R. Able—General Dynamics/Astronautics Div., P. O. Box 1128, San Diego, Calif., Attn: James Dempsey—General Electric Co., Missile and Space Vehicle Dept., 3198 Chestnut St., Philadelphia 1, Pa., Attn: H. W. Page—Goodyear Aircraft Corp., 1210 Massillon Rd., Akron 15, Ohio, Attn: R. W. Richardson—Grumman Aircraft Corp., Beth-Page, L.I., N.Y., Attn: L. J. Evans—Lockheed Missile & Space Co., Sunnyvale, Calif., Attn: L. E. Root—The Martin Co., Baltimore 3, Md., Attn: George Trimple—McConnell Aircraft Corp., P. O. Box 516, St. Louis 66, Mo., Attn: Walter F. Burke—North American Aviation, Inc., General Office, International Airport, Los Angeles 45, Calif., Attn: L. L. Waite—Republic Aviation, Conklin St., Mingsdale, L.I. N.Y., Attn: Hyman Stein.

NASA suggests that small business firms or others interested in subcontracting opportunities on this procurement make direct contact with the above firms.



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Dr. Carl E. Barnes: Formerly with Minnesota Mining & Manufacturing Co., joins FMC (Food Machinery and Chemical Corp.) as vice president for research.

Royal Weller: Named director of engineering, Space System Division, Lockheed Missiles and Space Co., Sunnyvale, Calif. Weller previously was vice president-engineering, Stromberg-Carlson Division of General Dynamics Corp.

Dr. Raymond L. Garman: Vice president-engineering and research, General Precision Equipment Corp., also named to new position of vice president and chief scientist of General Precision, Inc., the company's principal operating subsidiary. **David Balber** appointed director of advanced product development; **Maxwell B. Bassett** appointed vice president, systems management, and a director of General Precision, Inc.

Charles B. Miller and **Dr. Curtis B. Hayworth:** Appointed assistant technical directors of Allied Chemical's General Chemical Division, both headquartered at General Chemical Research Laboratory, Morris Township, N.J.

Dr. S. Dean Wanlass: Formerly with Aeronutronic Division, Ford Motor Co., joins Packard Bell Electronics as group vice president, Defense and Industrial Group. Dr. Wanlass will supervise Packard Bell's Technical Products Div., Computer Div., and Physical Sciences Corp., a 60% company-owned subsidiary.

Otto G. Quanrud: Former Director of Control and Guidance, Rome Air Development Center, N.Y., named planning engineer with the Advanced Planning Dept., Pan American World Airways' Guided Missiles Range Division.

Elmer P. Wheaton: Promoted to acting vice president-engineering, Douglas Aircraft Co., Santa Monica, assuming responsibilities of Vice President **Edward F. Burton,** who has been granted leave because of illness. Wheaton had been vice president-technical under Burton.

E. F. Coy: Named vice president and director of marketing, Military Products Div., Hoffman Electronics Corp., Los Angeles. Coy previously was with Electronics Associates, Inc.

Clarence E. Watson: Previously with Remington Rand Univac Div., Sperry Rand Corp., joins CBS Laboratories as vice president-business administration.

Al W. Mills: Appointed program manager for *Dyna-Soar* project being carried out by Sundstrand Aviation, Denver. Mills is being transferred from Los Angeles, where he was employed by Sundstrand on both the *Atlas* APS and Model 871A Flight Vehicle Power Unit. **George M. Christner** transferring to Denver as project engineer and assistant to the project manager; **Ted L. Ross** reassigned to Denver as *Dyna-Soar* program administrator.

Dr. Martin D. Schwartz: Appointed director of operations analysis, North American Aviation's Space and Information Systems Div., Downey, Calif. Formerly Dr. Schwartz was deputy chief of operations analysis in the office of Air Force vice chief of staff, Washington, D.C.

William A. Sipprell: Joins Guidance Technology, Inc., Washington, D.C., as vice president. Sipprell is former president of The Babb Co., New York.

T. Gordon Hame: Appointed manager of advanced development for communications, General Dynamics/Electronics' Military Products Div., Rochester, N.Y. Hame formerly was assistant professor, electrical engineering, Ohio State University.

Ugo A. Coty: Joins Aerojet-General Corp. as assistant to vice president, Azusa plant. Formerly Coty was with Lockheed Missiles and Space Division.

R. H. Nelson: Former manufacturing manager for Boeing Co.'s *Bomarc* missile program, named electronics manufacturing manager; **R. W. Lantz** named acting director of new electronics packaging group, both in Boeing's Aero-Space Division.

Rear Adm. Harold M. Briggs, USN (Ret.): Veteran of 38 years service, joins Washington Technological Associates, Inc. as president and chief executive officer. Adm. Briggs succeeds **Julian H. Ray,** one of WTA's founders, who will continue as chairman of the board of directors.

Gerald L. Phillippe and **Cramer W. LaPierre:** Elected president and executive vice president respectively, General Electric Co., New York City. Concurrently, both were also elected directors.

John J. Graham: With Radio Corporation of America 14 years, appointed to newly-created position of division vice president, Operations, of RCA's Electronic Data Processing Division.

Dr. David M. Gates: Appointed editor of Radio Propagation, Section D of Journal of Research, National Bureau of Standard, Washington, D.C. He succeeds **Dr. James R. Wait,** who will continue research in radio wave propagation and electromagnetic theory and as consultant to the Director, Boulder (Colo.) Laboratories.

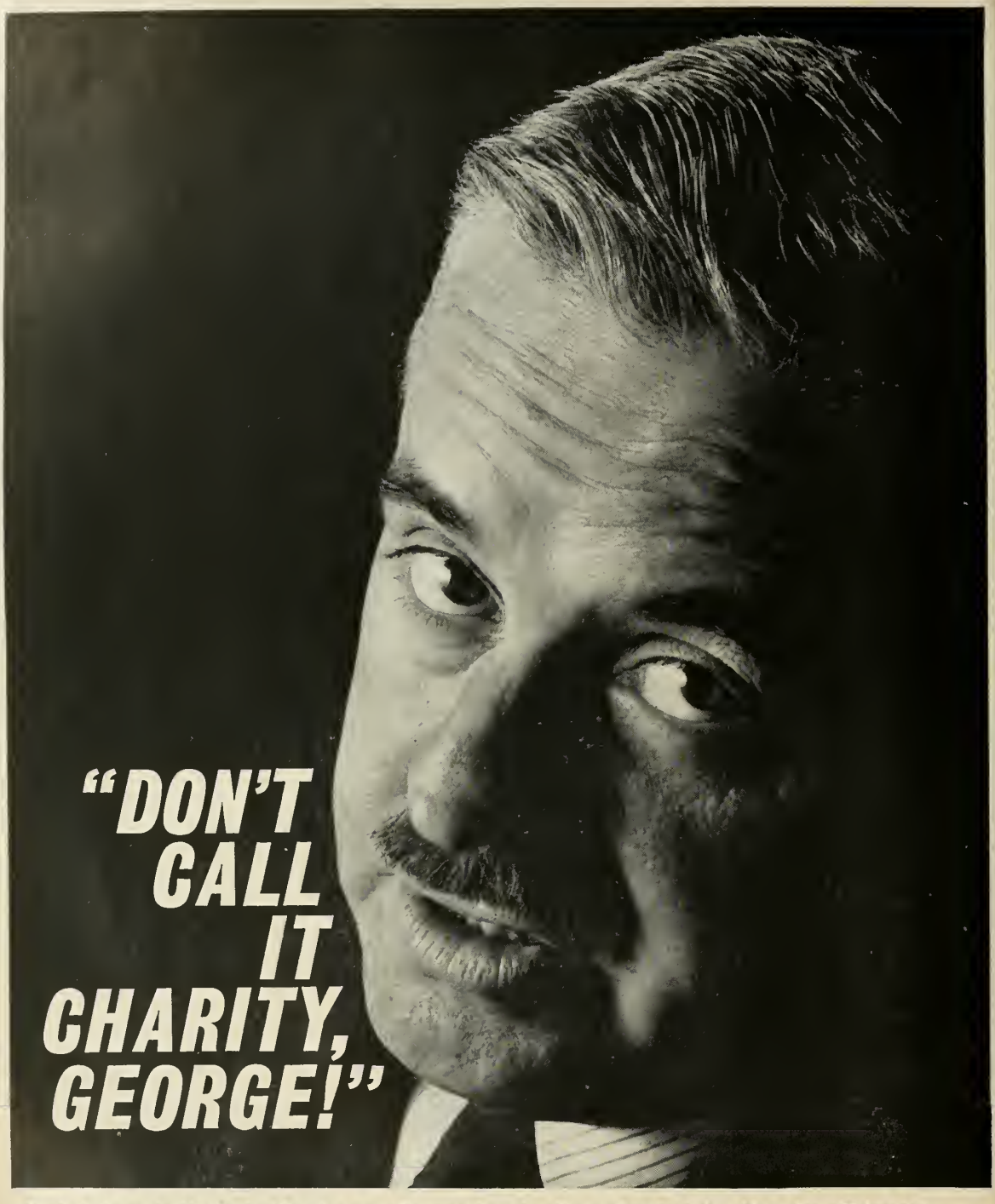
Dr. Lester M. Field: Named assistant group executive, Hughes Aircraft Co.'s components group, Los Angeles. Field also will continue as director of microwave tube division and a member of the company's technical board. **Lance P. Johnson** named to new corporate position of product exploitation director for Hughes/Culver City.

Henry W. Royce: Manager of command and control advanced design in electronics division, The Martin Co., Baltimore, elected general chairman of 1962 National Telemetering Conference to be held in Washington next May.

Dr. John W. Bond, Jr.: Former senior staff scientist for Defense Department's Institute for Defense Analysis, named director of military and space applications for Geophysics Corporation of America, Bedford, Mass.

Correction

M/R on July 31 identified John W. Boone, elected to the board of Airpax Electronics, as a "former" vice president of Radiation Inc. Actually, Mr. Boone is still a Radiation vice president, as well as an Airpax director.



"Contributions to the United Fund are really investments! Sure, charity takes the edge off hunger and misery. And that's necessary. But the agencies of the United Fund go way beyond that. They give the help that gets people back on their feet, makes them productive members of the community again. So it makes good sense to give the United Way—as an investment in a stronger, more prosperous community. Besides, that's the American way: to take care of our own, right at home. Our company makes a contribution, urges its employees to join in and makes it convenient through payroll payments. This once-a-year appeal cuts down the confusion of separate drives, too. It's more than a charity, George. It's an investment—and a duty—for your business and mine!" **GIVE THE UNITED WAY**

—when and where—

AUGUST

International Astronomical Union, 11th General Assembly, Pasadena, Calif., Aug. 15-24.

American Rocket Society International Conference on Hypersonics, Compton Lecture Hall, Massachusetts Institute of Technology, Cambridge, Aug. 16-18.

National Naval Aviation Meeting, Institute of the Aerospace Sciences, San Diego, Calif., Aug. 19-24.

Welded Electronic Packaging Association Symposium, Lockheed Missiles and Space Co.'s Palo Alto Research Facility, Calif., Aug. 21.

National Academy of Sciences 10th Pacific Science Congress, University of Hawaii, Honolulu, Aug. 21-Sept. 8.

Western Electronics Show and Convention (WESCON), Cow Palace, San Francisco, Aug. 22-25.

American Rocket Society Fourth Biennial Gas Dynamics Symposium, cosponsored with Northwestern University Technological Institute, Evanston, Ill., Aug. 23-25.

American Institute of Electrical Engineers, Pacific General Meeting, Salt Lake City, Aug. 23-25.

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Rover Progress

(Continued from page 23)

conducted at the lab to determine effects of high temperatures on fuel elements, including investigation of fission product escape under such conditions.

(2) Behavior of rocket reactors under abnormal operating conditions. Tests at the NTS will determine these parameters, probably including destruction of full-scale reactors.

(3) Leaching of reactors to determine what fission products would come into open ocean water if a reactor or parts of a reactor fell into the sea.

(4) Magnitude, dispersal and particle size studies of radioactive exhaust products produced by the reactor.

Estimated total cost of facilities at the Jackass Flats site is between $80 and $90 million, which includes maintenance and disassembly buildings, test stands, control centers, and other support equipment and facilities. Of these, AEC will fund about $7 million from its increased FY 1962 budget for the program, and NASA will fund about $15 million from its booster *Rover* FY 1962 budget.

Test cells at the site can use either gaseous or liquid hydrogen for rocket runs. Cells A and C will be used for Kiwi-B testing, and another, Test Cell D, will be the first downward-firing stand. The latter is expected to be in use early in 1963.

At Los Alamos, meanwhile, five more facilities are in various stages of planning for the *Rover* program. One now under construction is a $21,000 engineering test facility covering 1000 square feet.

Three others are in the design stage; a 13,600 square-foot addition to the LASL rolling mill, costing $605,000 and expected to be completed in February; a $110,000 reactor sub-assembly building of 4000 square feet; and a $725,000 addition of 7000 square feet to the radiochemistry building for 13 high-level hot cells.

In addition to these, a pulsed accelerator building has been requested in the FY 1963 budget. This facility would house a new Cockcroft-Walton accelerator to be used in the program.

• **Housing problem**—Part of the initial Nerva contract calls for Aerojet and Westinghouse to support the Kiwi-B reactor experiments, in preparation for Nerva work to be conducted. However, the 20-man team assigned to LASL for the purpose has not been able to move to Los Alamos because no housing exists there for them.

LASL said no housing of any kind is yet available for the team, either in Los Alamos or nearby Santa Fe, as a result of a continuing housing shortage. ❖

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Assignment: National Survival

FOR THE MISSILE/SPACE INDUSTRY, what can be said regarding Maj. Titov's remarkable orbital flight? We are irritated at the continuing necessity for sending well-deserved congratulations to the Russians on space achievements. This time, instead, we will send condolences to President Kennedy on the mess he has inherited and wish him Godspeed in his efforts to clear it up.

We find it less than amazing that the Soviet astronaut was able to sleep while in orbit. We have a nation full of people who have been asleep for years.

Until they wake up, we will continue to run second best to the Russians in this and many other fields. After a tour as a resident correspondent in Moscow three years ago, we came out convinced that to underestimate the Soviet Union would be fatal to this nation's survival.

We found our fellow Americans only mildly interested in this appraisal and much more inclined to gauge Soviet capabilities by the quite apparent fact that Russians wore shabby clothes. The suggestion that the Soviet Union was concentrating on things more important than Paris fashions met with doubt from a great number of people who should have known better.

President Kennedy, summing up the balance of power in the Berlin crisis, faces a harsh reality which many in this country, including some in this industry, still have not acknowledged. Space achievements will play a vital role in international politics.

The Administration and the Congress have led the way in establishing the military and civilian programs to provide this nation with the space power it requires to survive.

The job now is squarely up to the missile/space industry. Never in the history of this country has a single industry been handed a more important task. Survival as a world power depends on our performance.

What then must the industry do? What can the president of the electronics component firm, the scientist working on life support systems, the engineer designing retro-rockets do?

As trite as it may sound, a primary objective should be development of pride in being a part of the team which must do the job. This must go far deeper than just the prime manufacturers.

North American Aviation was one of the pioneer firms in recognizing the broad and manifold activities required for survival in the missile/space industry. It was one of the first aircraft companies to start the necessary diversifications.

The following remark by its able president, J. L. Atwood, before the New York Society of Security Analysts last month, is therefore of more than passing importance:

"What was once called the aircraft industry has clearly become something else that almost defies classification. The industry now refers to itself as the aerospace industry, but this does not encompass all of the large fields—such as submarine and electronic information systems—in which individual companies including North American may be involved. Yet despite this diversification in different directions —often to the point where firms such as North American are doing less business in aircraft than in other activities—the companies listed on the various stock exchanges are referred to as the 'aircrafts.' . . . My point is that the industry is in the midst of fantastic change, that the full extent and pace of this change must be understood, and that generalities are hardly ever valid."

The extent and pace of the change must indeed be understood. And it must be understood that the missile/space industry includes many firms never in the aircraft industry, including large electronics companies, new metal-working firms, small electrical component manufacturers and others.

These all must recognize and take pride in their role as members of the missile/space team which has been handed the nation's most critical assignment, that of matching and exceeding the Russians in space.

Once the fact that this team exists is fully acknowledged, once the pride in being a member of it is developed, then the momentous task facing us can be tackled with a vigor that will guarantee success.

FOR THOSE OF US in the missile/space industry it can no longer be sufficient to sit back and "let Joe do it." Our next-door neighbor perhaps can shrug and say, "Yes, I realize all that about the Russian menace but there is nothing I can do about it." *We* no longer can do that.

Every single one of us in the industry has been handed the job of doing something about it. That includes the vice president-financial of the propulsion company, the electrician on the construction gang at Canaveral, the contracting official at NASA, the *Dyna-Soar* pilot in training at Edwards AFB, the machine tool designer, and the project engineer on the moon vehicle. If we fail the nation, it will be plain in the pages of history where the blame lies for the disappearance of democracy from planet Earth.

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William J. Coughlin



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AUGUST 21, 1961

missiles and rockets

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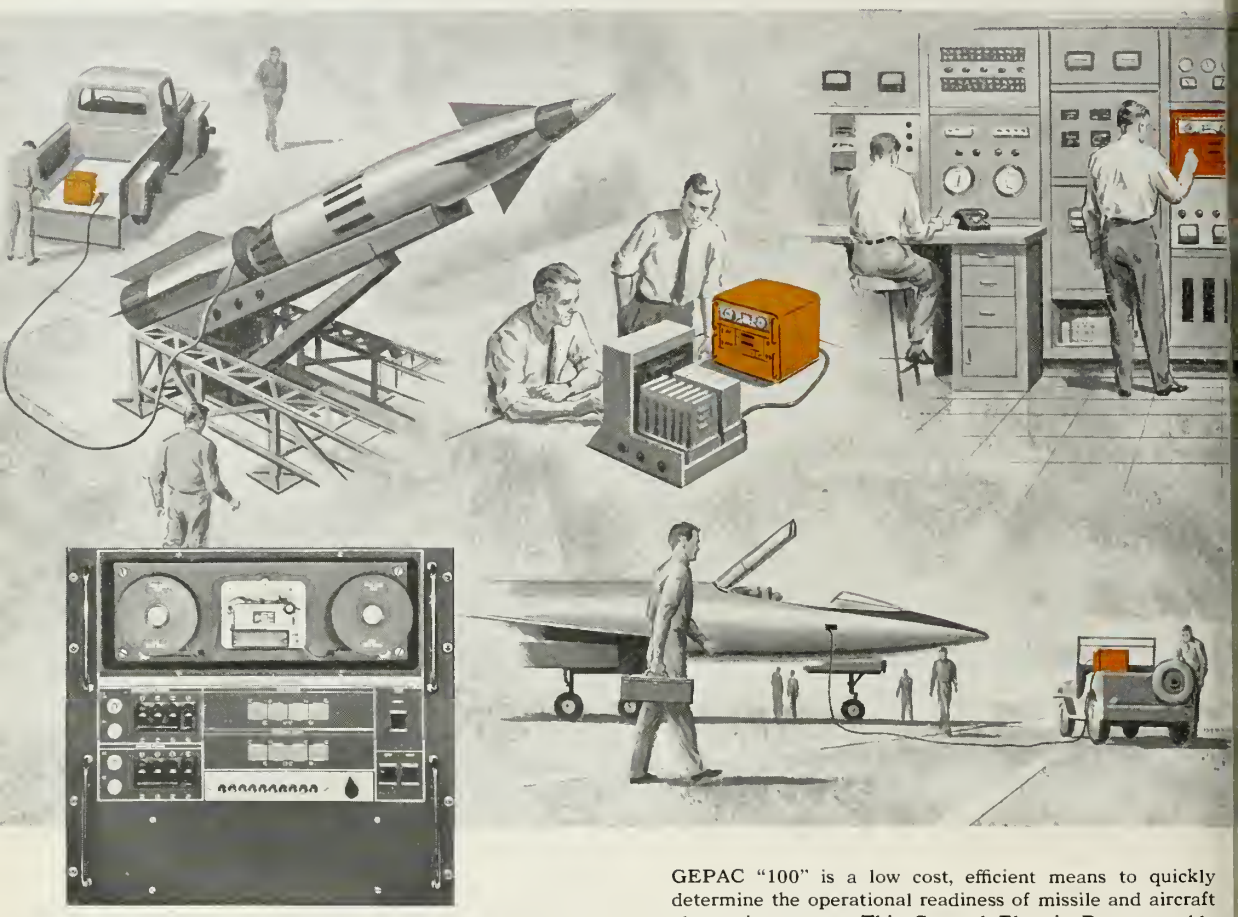
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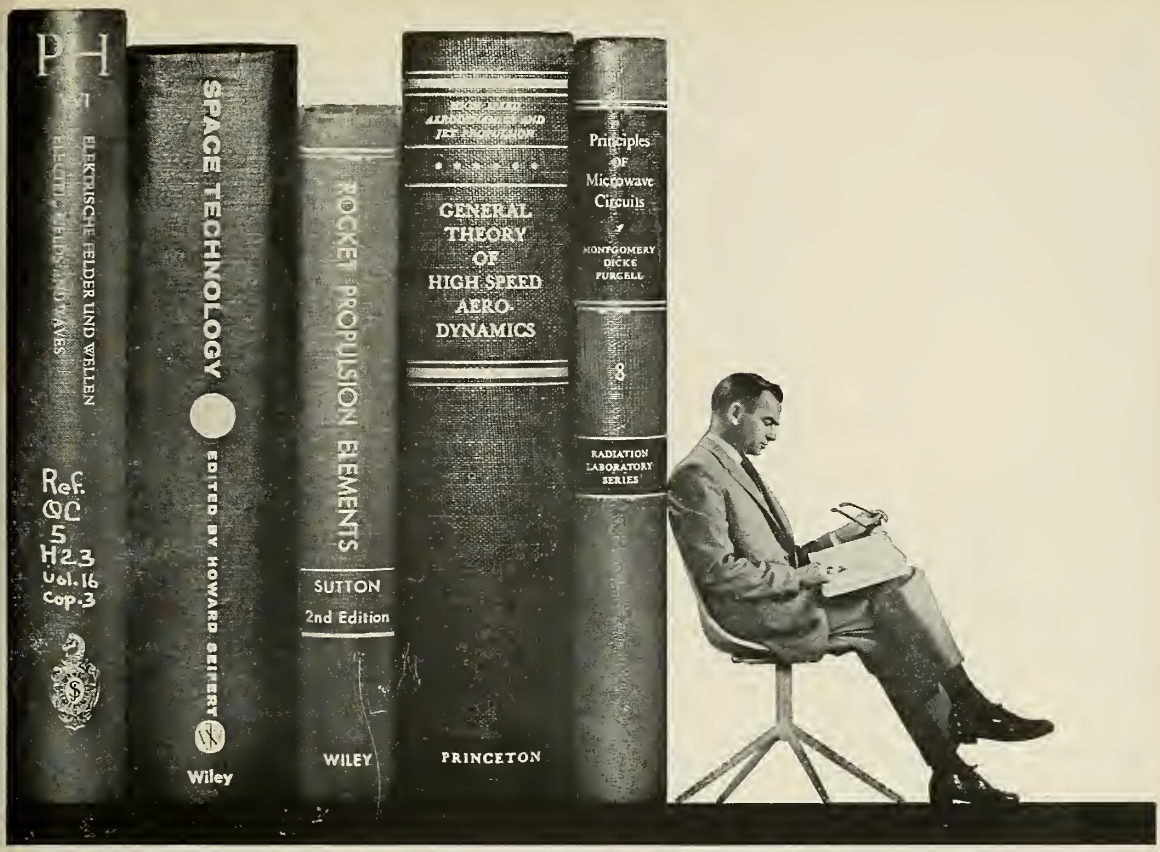
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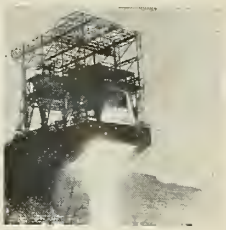
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THE COVER

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† U.S. Reg. Pdg.

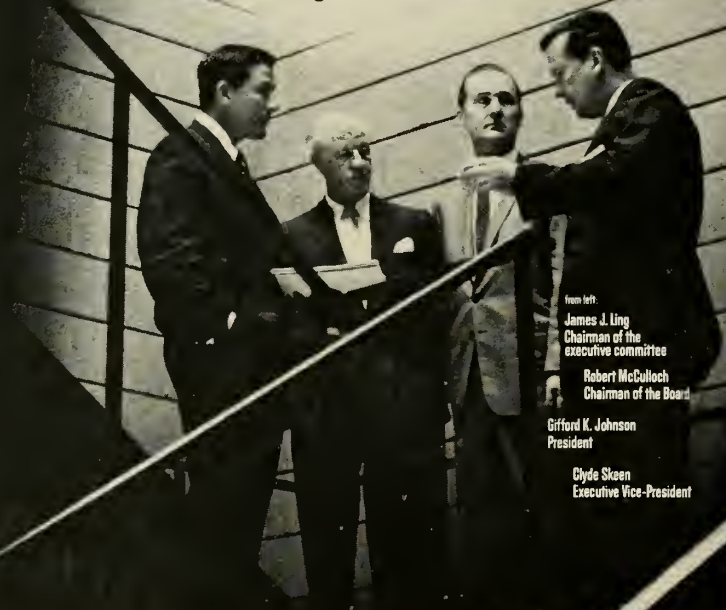
35,251 copies this issue

The stockholders of Chance Vought Corporation and Ling-Temco Electronics, Inc., on June 30, 1961, approved plans for combining these two companies into a vast new company — Ling-Temco-Vought, Inc., to be effective August 31, 1961.

Combination of these dynamic, experienced organizations will link depth of capabilities with depth of management to meet the advanced challenges of electronics, space, communications, aircraft, and missiles.

Ling-Temco-Vought will employ more than 20,000 people in the development and production of: AEROSPACE SYSTEMS . . . ELECTRONICS . . . COMMUNICATIONS . . . SOUND SYSTEMS . . . AERO SYSTEMS . . . INFORMATION HANDLING SYSTEMS.

This will be . . . . Ling-Temco-Vought, Inc. . . . a new industrial leader to serve America's future through science.



from left:
James J. Ling
Chairman of the executive committee

Robert McCulloch
Chairman of the Board

Gifford K. Johnson
President

Clyde Skeen
Executive Vice-President

LING-TEMCO-VOUGHT, INC

LTV

*Proposed new name for the combined companies after August 31, 1961: CHANCE VOUGHT CORPORATION AND LING-TEMCO ELECTRONICS, INC.

DEPTH MANAGEMENT FOR PROGRESS IN AEROSPACE ELECTRONICS AND COMMUNICATIONS



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Electron Corporation

SOUND SYSTEMS
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Altec Service Company
Peerless Electrical Products Division
University Loudspeakers, Inc.
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LTV
LING-TEMCO-VOUGHT, INC.
DALLAS, TEXAS

*Proposed new name for the combined companies after August 31, 1961
CHANCE VOUGHT CORPORATION AND LING-TEMCO ELECTRONICS INC.

Circle No. 3 on Subscriber Service Card

letters

Soviet Bombers

To the Editor:

I am against dull, loaded TV exercises, which your editorial (M/R, Aug. 7) describes the recent LeMay panel as being. I did not view it, but if it is as you report, I can't see where you're wrong in your view.

On the other hand, I can't go along with an earlier editorial (M/R, July 31) in which you brush aside all these Russian planes shown at Tushino as "old stuff."

They may be. But as an old aviation reporter who's been up in some of our best planes, and owner of a Mach-buster pin, those Russian machines looked mighty ominous to me. Particularly the Beauty and the Bounder. My God—I hope you are right! I hope the Russians do not have a big fleet of these planes, because stopping them looks like a very tough job to me.

One thing I would like to know. Why does it take us so long to wring the bugs out of a new plane? I've been doing pieces on the F-105—years and years ago I really waxed wild on this machine—and so far as I know, after years and years and years, the damned thing is *still* not free of black-box trouble.

I wouldn't sell planes short, though. I'm still not convinced these missiles can hit with the kind of accuracy you need to do the job—particularly over long ranges, and so far as the *Polaris* is concerned, if it hits it's the greatest, but how in the world can it hit from the bottom of the sea if we can't even fire an astronaut with accuracy from dry land over a vacuum-cleaned, ribbon-festooned prize course?

Frank Harvey
Hackettstown, N.J.

Reporting in Depth

To the Editor:

18,000 fathoms of water!!! ("MR-4 Winds up Suborbital Series," M/R, July 31, p. 16). At 6 ft./fathom your article leads one to believe that the Atlantic Missile Range has a water depth of 108,000 feet!! This exceeds the previous known Atlantic depth record (Milwaukee Deep off Haiti, 30,246 ft.) by a factor of about 3.5. Surely you mean 18,000 *feet* of water. How many *Mercury* capsules full of mail did you receive on this boner?

Thank you for a usually fine publication.

Henry W. Wedaa
Head, Ordnance Applications Dept.
Aerojet-General Corp.
Downey, Calif.

To the Editor:

Congratulations on M/R's amazing announcement of the outstanding ocean deep of all time! We had always thought the Mindanao Trench at approximately 6200 fathoms was the greatest depth known—but it doesn't hold a candle to 18,000 fathoms!

Even if the *Liberty Bell 7* capsule had fallen into the Puerto Rican Trench it could hardly have sunk any deeper than 4500 fathoms, unless it was powered to drill into the floor.

We have been a steadfast subscriber since Issue No. 1 and look forward to each issue with interest, but don't shake our faith in the veracity of M/R's coverage of aerospace activities. After all, the current run-of-the-mill news in this field is sensational enough without attempting further embellishment.

Franz Joseph Schaubelt
Member, I.A.S.
La Mesa, Calif.

To the Editor:

If memory serves me the deepest depth of the ocean is something like 35,000 *feet*. The newscasts at the time gave the same depth—18,000 fathoms. Should this have been 18,000 feet?

Thank you very much for a splendid job in your magazine.

William T. Rogers
Billings, Mont.

Yes, yes, 18,000 feet. Might as well have been fathoms.—Ed.

Proper Sparrow

To the Editor:

The Fifth Annual World Missile/Space Encyclopedia in M/R July 17 contains data covering the Navy *Sparrow III* missile. The photograph accompanying the specifications shows a group of dollies carrying *Sparrow I* missiles.



THE REAL SPARROW III.

Your encyclopedia is comprehensive and will become a source of reference and authority. We know you will want it to be accurate. You may wish to correct this error by printing the enclosed photograph of the Navy's *Sparrow III*.

Harold Berman
Technical Information Officer
U.S. Naval Missile Center
Point Mugu, Calif.

Ski-Launch De-energized

To the Editor:

This whole Russian ski-launch discussion (Letters, M/R, July 31, p. 6) puzzles

(Continued on page 36)

NEW NAVY... NEW WEAPONS



New naval defense concepts are vital in these days of nuclear submarines and guided missiles. One of these: A destroyer-class hydrofoil boat guided to lurking enemy submarines by remote sonobuoys. Ford Instrument is now working to turn this new concept into operational hardware . . . one of the most recent efforts in our 46 years of service to all branches of the armed forces.

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Ford Instrument guidance and control components participated in these missile and space "firsts": First Free-World man-into-space vehicle (MERCURY-REDSTONE) • First operational ballistic missile (REDSTONE) • First successful launching of a Free-World satellite • First successfully recovered nose cone • First successful Free-World space probe. 1.4

A CREATIVE TEAM OF SCIENTIFIC, ENGINEERING AND PRODUCTION TALENT

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The Countdown

WASHINGTON

NASA '63 Budget to Hit $4 Billion

Budget estimates being prepared by NASA for FY '63 are expected to call for expenditure of close to $4 billion—more than double the $1.7 billion for the current year. More than half will go to the lunar program.

Jupiters in the Green

All or nearly all of Italy's 30 *Jupiter* IRBM's are now understood to be operational. Earlier this month, Italian Air Force missilemen successfully launched a *Jupiter* from Cape Canaveral in a combat training exercise. It was the second to be conducted.

Polaris: A Super Super?

The Navy is considering the development of a follow-on to the *A-3 Super Polaris*. The Lockheed *A-3* is being designed to have a range of 2500 nautical miles. It is expected to be operational in 1964. The *A-4* Super Super would have a range of 4000 to possibly 5000 miles. Company studies are under way.

New Pressure for Satellite Defense

One significant reaction to the flight of Russia's *Vostok II* is the increased demand within the Armed Forces for a defense against military satellites and spacecraft. One strong source of the increasing push for a space defense system is NORAD.

DOD Electronics Buy Up 37 Percent

Analysis of the final defense budget figures passed by Congress show the FY '62 appropriations bill provides a total of $1.37 billion for the procurement of electronics and communications equipment for all three military services. This is $370 million more than was appropriated for FY '61. The Administration's July defense budget revision alone added $180 million of the total increase.

On the Pad

Technical troubles apparently have been cleared up and NASA expects this week to get off the long-delayed first shot of the *Ranger I* lunar spacecraft from Cape Canaveral . . . From Wallops Island, Va., the backup of the *S-55* micrometeoroid satellite also is ready for flight aboard a *Scout*.

Jobs by Sleight of Hand

Expect NASA to get around the $112-million cut in its FY '62 budget, which included some $20 million in salaries and expenses, by some administrative sleight of hand. Otherwise, the agency won't be able to hire half of the 4900 new employes it says it needs this year. . . . Man-to-know for future NASA programing is D. D. Wyatt, who is heading up a new Office of Programs under Associate Administrator Robert C. Seamans Jr. Wyatt's office will have policy review status in determining what funds will be spent on particular projects—and when.

INDUSTRY

In Search of Apollo Chief

Announcement of a boss for NASA's *Apollo* lunar program is believed to be imminent. For the past few weeks NASA Administrator James Webb has been consulting with dozens of missile/space industry executives, seeking their advice on the type of management the big program should have. Presumably, he's been sounding out some of them on whether they would like the job.

R&D Intelligence

COUNTDOWN hears that specs for the big *Nova*-type solid booster are changing almost daily—much to the bafflement of the solid propellant industry. Still unresolved is the fundamental question of whether it will be a one-piece or segmented motor. . . . RCA has come up with a precision missile and satellite tracker which the company says has an accuracy approaching 5 ft. at 2000 mi. . . . Solution to the ignition problem in small storable liquid rockets now seems in hand, and there reportedly is a quickening of interest in this propulsion area, particularly in the Navy.

GE Awarded Secret Samos Contract

Work at GE's Missile & Space Vehicle Division has been officially tied for the first time to the development of *Samos II*—an advanced version of the Air Force's closely-guarded reconnaissance satellite. The Air Force announced that it awarded GE a $1,133,000 contract for *Samos II* R&D. No further details were disclosed.

Ford Competes for Saturn

Ford Motor Co. is stepping into the competition for the multimillion-dollar contract to build *Saturn C-1's*. A company team is being set up at Ford's Aeronutronic Division, Newport Beach, Calif., under Roy P. Johnson—former Aeronutronic marketing manager and *Shillelagh* missile program manager. Johnson will be assisted by John B. Lawson, manufacturing operations manager of Ford's transmission and chassis division.

UTC's Satellite Booster

A booster being developed by United Technology Corp. for putting communication satellites into orbit will have four stages, all solid-fueled. Described as a "giant *Scout* type," the vehicle has UTC P-1 and P-2 boosters as its lower stages. The two upper stages are smaller motors.

INTERNATIONAL

British Redeye Buy?

Britain is reported considering the purchase of Convair *Redeye* antiaircraft missiles to supplement Army defenses which now rely solely on the English Electric *Thunderbird*. The Army wants *Redeyes* to protect against low-level air attack.

Overseas Pipeline

Jodrell Bank's Sir Bernard Lovell is the first recipient of a $1000 Guggenheim International Astronautics award presented by the International Academy of Astronautics. . . . A VLF transmitter for *Polaris* submarines is being built in Britain as part of the NATO defense network. . . . Some 47 countries are now involved in NASA's international program, many of them just seeking scientific information. . . . The Russians are now showing a film in the West called: "With Gagarin to the Stars."

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PIKI I	15 8 x 4 4	16 9	1,115
JUOI I	66 0 x 3.0	23 8	3,900
PIMA I	33.4 x 5 6	48 8	6,030
HOPI I	80 4 x 4 5	74 4	11,900
KISHA I	72.1 x 6 5	145 0	21,300
KIVA I	106 7 x 6.5	216.0	33,500
GILA III	101.6 x 9 0	396 0	65,500

FOR TECHNICAL DATA on any of these motors, write for Technical Bulletin #1400.

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The Missile / Space Week

DOD Budget: Tomorrow—and Today

Defense Secretary Robert S. McNamara outlined his philosophy of budget-making in newly-released congressional testimony.

"I consider the budget nothing more than and nothing less than the quantitative expression of a plan or policy," he said. "So in developing the budget I propose to start with the plan or the policy and translate it into quantitative terms, terms of benefit or cost."

He assured Congress that this would be the guideline followed in formulating the budget for FY '63.

Meantime, Congress finally passed and sent to the White House the thrice-revised DOD money bill for FY '62.

The bill provides $46.6 billion. It contains all of the successive revisions and additions sought by the Administration plus some three-quarter billion dollars for bomber procurement and B-70 R&D which the Administration has repeatedly said it doesn't want.

Paradoxically, the bill still provides for a 2 percent across-the-board reduction in procurement funds. A total cut of $344.8 million in missile and aircraft funds.

The bill is $6.4 billion higher than the bill for FY '61—$5.8 billion higher than the Eisenhower lame duck bill. It is the biggest peacetime military appropriation bill in U.S. history.

Shots of the Week

• NASA apparently successfully launched last week its *S-3* satellite, designed to study the relation between magnetic fields and space radiation.

Officials at Goddard Space Flight Center—which conducted the test—said that while it would be a couple of days before its orbit could be determined, "everything looks good at this point."

The uncertainty was caused by the satellite's highly elliptical orbit.

• An Army *Pershing* was destroyed 52 seconds after what appeared to be a perfect launch when the missile veered sharply off course. The Army said trouble developed in the burning time of the second stage when the *Pershing* had traveled about eight miles from the Cape.

• Swedish scientists fired a U.S.-made *Arcas* over the Lapland test range at Vidsel on the Arctic Circle Aug. 14. The nose cone was blown up on command at 55.8 miles altitude, sending an artificial cloud nearly 100 miles over the launching platform.

• A 15-ft. *Aerobee* was launched and ignited underwater in what Aerojet-General Corp. calls the first successful achievement of its kind.

Dixon to Replace Ostrander

Thomas F. Dixon, currently Vice President for research and engineering at the Rocketdyne Division of North American Aviation Inc. takes over as director of NASA's Office of Launch Vehicle Programs on Sept. 18.



DIXON

He replaces Maj. Gen. Don R. Ostrander, who is returning to the Air Force as Vice Commander, Ballistics Systems Division Air Force Systems Command. Ostrander has been OLVP Director since Dec. 16, 1959.

Dixon—employed by NAA for the past 15 years—directed the development of liquid propellent engines for such missiles are *Atlas, Thor, Jupiter,* and *Redstone.*

F-1 Test Firing

Rocketdyne has revealed that more than 140 tests at over a million pounds of thrust have been made to date in the *F-1* development program.

The powerful booster, under consideration for use in *Nova,* developed over 1 million pounds of thrust Aug. 16 at Edwards AFB, Calif. during the first series of tests of the complete flyable system (see cover).

F-1 will eventually have a thrust of 1.5 million pounds and a duration of two and a half minutes. A Rocketdyne spokesman said a record thrust of 1,640,000 pounds was achieved in a thrust chamber test. He said Rocketdyne is aiming at a reliability

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in the *F-1* "higher than the reliability established by the *Redstone* engine, with only 78,000 pounds of thrust, which carried this country's first astronauts . . ."

X-15 Number Two

The second *X-15* rocket plane had its first test flight Aug. 10, piloted by Navy Commander Forrest Peterson. The NASA experimental craft's flight had been delayed for almost a month by technical difficulties and adverse weather.

Saturn at Cape

The *Saturn* booster is in Cape Canaveral after its 2200 mile barge trip from Huntsville. Workmen immediately began preparations to erect the 82-ft. booster on its pad. First flight test is scheduled for October.

Huge Helium Plant Contracted

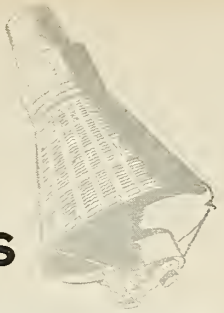
The first contract in the Department of Interior's helium conservation program was awarded the Helex Co., a subsidiary of Northern Gas Co.

The first of several plants, to be built under a program which will ultimately save 52 billion cubic feet of otherwise wasted gas, will be at Bushton, Kan. It will be the world's largest helium facility, producing raw helium to be purchased and stored by the Bureau of Mines. The company will be paid up to $11.24 per thousand cubic feet for all helium produced in the plant up to a maximum amount. The 22-year contract calls for delivery of the first helium no later than Jan. 1, 1963.

Echo Satellite One-Year-Old

Echo celebrated its first birthday last week and NASA believes the communications satellite may last until midwinter and perhaps another year.

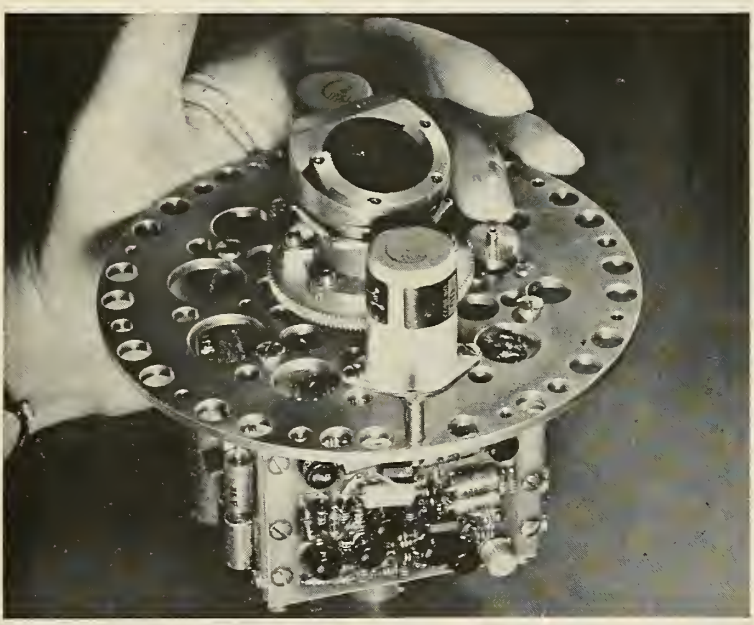
The giant balloon has traveled more than 138 million miles on nearly 4500 trips around the earth. Experiments with *Echo* have virtually halted, but a signal sent a few weeks ago was bounced back, amazing some scientists, who originally predicted a useful life of one week for the satellite.



Bristol choppers help first U.S. Astronaut maneuver space capsule

Four Bristol Syncroverter* choppers formed a vital part of the infrared horizon sensors manufactured by Barnes Engineering Company, Stamford, Conn., and carried aloft in NASA'S MERCURY capsule by the first U.S. astronaut to reach outer space.

The Bristol choppers function as sensitive phase detectors in the sensors as they establish a horizontal reference plane for the vehicle.



Infrared Horizon Sensor undergoes rigorous optical, mechanical, and electrical checks at Barnes Engineering Co. One Bristol chopper is located in foreground, in front of gear.

Bristol Syncroverter* choppers, noted for low noise, long life and high reliability, are finding a vital place in more and more missile guidance systems, as well as in analog computers, d-c amplifiers, and test equipment for industrial applications. More than 200 models available. Write for complete details.

The Bristol Company, Aircraft Equipment Division,
173 Bristol Road, Waterbury 20, Conn.
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To stop Red masses . . .

West Is Dependent on Nuclea

But Army maneuvers show we are short in adequate tactical missiles as well as lacking in conventional force

by James Baar and William E. Howard

HEADQUARTERS EXERCISE SWIFT STRIKE, FORT BRAGG, N.C.—The Army and Air Force staged a "Little Berlin" dress rehearsal last week in the woods and fields of the Carolinas.

The clear verdict for the short haul:

The use of tactical nuclear weapons by NATO forces on the Central European Front is inevitable if the Red Army moves in force.

The verdict for the long haul:

The Army is almost as desperately in need of more equipment to fight a tactical nuclear war as it is of more equipment to fight a conventional war.

Some 38,000 men and 515 aircraft took part in the big maneuvers which began the week of Aug. 7 with mass airborne landings. The maneuvers were the largest staged in the United States since 1941.

Moreover, the principal participants were the 101st and 82nd Airborne Divisions—two thirds of the Strategic Army Corps, the bulk of the Army's existing combat-ready central reserve, unquestionably the first units that would be sent to reinforce NATO on the Central Front this fall—if the Berlin situation continues to deteriorate.

The participation of these divisions and the Air Force reserve units that would be ordered to support them gave far greater significance to the Exercise Swift Strike maneuvers than they ordinarily would have had. Swift Strike was a dry run played out in the teeth of the increasingly tense international struggle.

The war problem assumed for the maneuvers had many similarities to the Berlin situation. A Communist satellite nation begins to overrun a nation tied to the United States by treaty. The attacked nation appeals for help; the United States responds. The satellite nation, in turn, calls for help from its major power backer.

The similarity with Central Europe is fairly direct: East Germany attacks Berlin or West Germany. The United States comes to the aid of Berlin or West Germany. Russia comes to the aid of East Germany.

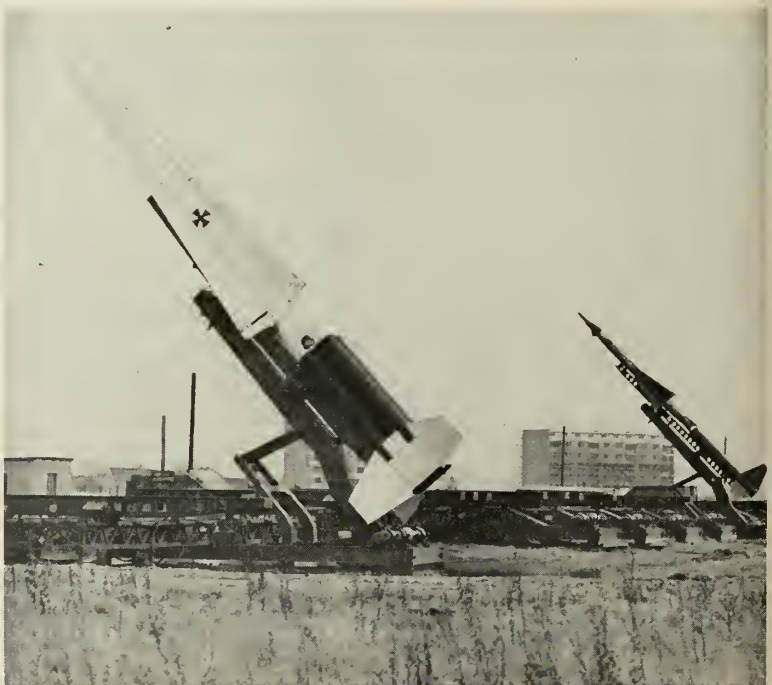
• **Artificial odds**—However, in the problem, both sides were assumed to have the same number of nuclear weapons, the same size Air Force and roughly the same size Army.

In Central Europe today, NATO is considered to have a superior number of tactical aircraft and a superior number of nuclear weapons of various sizes. Russia is considered to be capable of rapidly putting a much larger, far more mechanized and better equipped army in the field.

The equal forces that faced each other in the Carolinas fought with conventional weapons for several days before using nuclear warheads. And, even then, nuclear warheads were not introduced as an absolute necessity.

But, in Central Europe, the tactical trump card of the NATO forces is their nuclear weapons. The trump card of the Communist forces is the rapidly reinforceable Red Army. If the former is not played swiftly, the latter can eliminate it with conventional weapons.

Even a passing hope that NATO forces might hold the Red Army at bay for any length of time with the kind of equipment and conventional weapons employed in Exercise Swift Strike is based on most flagrant pipedreaming.



LONELY SENTINELS are West German Nike-Hercules (foreground) and Nike-Ajax ready on launchers in strategic Rühr Valley. Note German cross on Hercules.

Missiles



NATO TROOPS fire Honest John in training exercise. These, like most in NATO's arsenal, are obsolescent birds.

• **Familiar weapons**—For the most part, with a few modern touches, the 101st and 82nd Airborne Divisions re-enacted the Korean War.

The bulk of the airlift for the approximately 12,000 paratroopers who jumped ably into Carolina watermelon patches from about 1200 feet was made up of obsolescent, plodding C-119's and C-123's.

The mainstay of the tactical fighter force that provided air cover for the transports and ground support for the attacking armies was the subsonic F-84.

The 101st fought with newly-issued M-14 rifles, but everyone else carried World War II M-1's. The 101st is the first major unit in the U.S. Army to be equipped with the new rifle.

The *Honest John* was the only missile deployed with the ground forces. Each side had 16. Each side also had four eight-inch howitzers which are capable of launching nuclear shells.

However, *Honest John* is an eight-year-old missile considered to be obsolescent. None of the Army's newer missiles such as *Little John, Sergeant* or *Davy Crockett* were deployed.

In the air, the Tactical Air Command had a handful of F-105 Mach 2 jets which are capable of carrying air-to-surface *Bullpups* as well as nuclear bombs. Other Century Series jets capable of carrying air-to-air missiles and nuclear bombs also took part.

But the F-105's put in relatively few appearances and none with *Bullpups*. The other Century Series planes were far outnumbered by the older types.

The major modern touch in the air was the introduction of TAC's new airborne command post—a redesigned KC-135 jet tanker. The air battle and parachute drops were directed from the command post by a major general and his staff.

The lack of more modern missiles in the field was bluntly pointed out in a fact sheet distributed by the Strategic Army Corps.

"Missiles and rockets are operational in STRAC artillery," the fact sheet said. "But they are either too few or already are outdated by weapons off the drawing boards and tested but not in production.

"In order to fight the limited warfare of today's cold war, modern massive firepower weapons are needed to contain and hold the battle area and check the spread of aggression by fast shifts of men and material to possible new brushfires."

The dire lack of other modern equipment needed to fight both tactical nuclear and conventional actions has been stressed repeatedly by the Army.

• **Problem is quantity**—As late as last March, when the Administration was still shelving Army proposals for greatly increased procurement of modern weapons, Lt. Gen. R. W. Colglazier, Army Deputy Chief of Staff for Logistics, told the House Armed Services Committee:

"We have developed (the M-60 tank) to contend with not only the Soviet main battle tank, the Russian T-54, but also with the latest Soviet heavy tank. . . . We have the qualitative aspects of tank modernization in production; however, it would take approximately 12 years at current production rates to replace our inventory of M-48 Patton tanks and older models with future tank procurement."

"At present rates of procurement several years will elapse before the Army has its acquisition objective for the M-113 armored personnel carrier. Approximately one-fourth of the Army's quantitative needs . . . are on hand or under contract.

"Currently the Army has one-fifth of its needs for the modern (M-14) rifle either on hand or on order. . . ."

Finally, he added: "The payoff for material modernization is not realized on the drawingboard but only when the equipment is in the possession of troops and is supported by adequate reserves for combat."

The procurement provided in the latest increases in the FY '62 defense budget will be only a beginning toward providing the missiles and other equipment to make a modern fighting force out of the current 14-division Army.

To add two more divisions as the Administration has indicated it may by alerting reserve units and draft increases will call for still more.

Swift Strike told nothing new: It only dramatized what Army officials have been saying for years. The United States has nothing in ground forces that would be a match for the Red Army in a conventional war. The U.S. tactical nuclear forces can stop the Red Army—but much more is needed quickly. ⌗

Nuclear Dry Run

Exercise Swift Strike gave the Army an opportunity to test its logistics system for nuclear-tipped missiles in the field.

A total of 32 *Honest Johns* were deployed with ground forces during the maneuvers. Each side had 16.

The *Honest Johns* were brought into rear areas by Air Force cargo aircraft and were stored at three centers called SASP's — Special Weapons Ordnance Points.

One SASP was at the rear of the red army; one at the rear of the blue; a third in a rear area available to both sides.

Officially the missiles were corps weapons allocated to division commanders. The commanders, in turn, could draw on the SASP's for missiles that had been placed in their control. Meantime, the commanders already had deployed the missile launchers.

When ordered, the missiles were transported to the desired firing points by Army aircraft — helicopters and Caribou fixed-wing planes.

In press interview . . .

Titov Hints Vostok II Has Wings

RUSSIAN SPACEMEN are dropping more broad hints that their orbital spacecraft are winged or have lifting surfaces—but they are still swathing technical details in a fuzzy blanket of secrecy.

The fuzziness was most apparent during a meeting in Moscow Aug. 11 with correspondents by the Soviet Academy of Sciences president Mstislav Keldysh and Major Gherman S. Titov, who orbited the earth for 25 hours Aug. 14.

Both Keldysh and Titov carefully avoided any explicit description of the *Vostok II* spacecraft and its operation. Even so, some new information was disclosed beyond that which followed the flight of *Vostok I* April 12.

One of the hints about the capabilities of *Vostok II* came from Keldysh, who said the cosmonaut could make all the maneuvers required for scientific observations and "land at any point on the globe."

In reply to a question whether the Russians might give some advice to American astronauts, Titov said:

"It is difficult to give advice. We fly quite differently."

• **Nuclear bomber?**—Asked whether *Vostok II* could carry a bomb any place in the world, Titov left the military threat unanswered by replying:

"The Soviet government has repeatedly pointed out in its statements that the space explorations in the U.S.S.R. serve peaceful purposes only. But since I am asked I can say: The *Vostok II* ship is not adapted for carrying bombs."

(The question, which was dropped there, apparently alluded to Premier Khrushchev's boast Aug. 9 that Soviet scientists could build a 100 megaton bomb which could be "launched aloft" —presumably by missile or spacecraft. American officials wrote off the 100 megaton bomb boast, contending the U.S. could build one just as powerful but there was no point in it when a 10 or 20 megaton weapon would be equally effective over most targets. But they didn't tie it to a space weapon.)

At another point, the major said that he took over manual control of the spacecraft after he was in orbit and found "the ship obeyed the controls beautifully; I could orientate it in any direction and send it anywhere at any moment," according to the Tass transcript of the press conference.

Taken as a piece, these statements would indicate rather clearly that *Vostok II* has a closer kinship with a *Dyna-Soar* type spacecraft than with NASA's *Mercury* or *Apollo* vehicles, which are both ballistic in configuration and have very limited maneuverability.

There was no explanation of how Titov maneuvered the spacecraft.

• **Choice of landings**—One new piece of information revealed by Titov was that he had a choice of landing in the spacecraft or landing by parachute after ejection in his seat from the cabin at a low altitude. He said he chose the latter method. Escape capsule ejection with parachute landing is being considered for both *Dyna-Soar* and *Apollo*, but there is no way of determining if they would be comparable to the *Vostok II* mechanism.

Titov, who said the spacecraft could have held two persons but was not designed for it, indicated that he kept the helmet of his spacesuit open most of the time. He said the air in the cabin was "better than in our cities."

A space medicine expert from the Soviet Academy of Sciences, Prof. Vladimir I. Yazdovsky, disclosed that like *Vostok I*, *Vostok II* was equipped to maintain the occupant for 10 days in space.

Yazdovsky said Titov's otolith organ in his inner ear, which controls the sense of balance, was temporarily affected at the beginning of the flight, causing Titov "unpleasant sensations." He said they disappeared when Titov avoided sharp movements of his head. ⌘



F-1 Engine Configurations Unveiled

POSSIBLE BOOSTER combinations using the Rocketdyne F-1 engine—including the Saturn C-3—were revealed last week by NASA's Marshall Spaceflight Center. The various combinations apparently are designed for lifting a 50 to 70-ton Apollo spacecraft to the moon.

First step in speed-up . . .

NASA Goads Mercury Orbit Program

MA-4 launch schedule moved up by about two weeks; but officials concede that manned flight may slip to '62

by Hal Taylor

NASA IS QUIETLY applying pressure to the trouble-dogged *Mercury-Atlas* program in hopes of getting an American into orbit this year. The speed-up—along with efforts to get the *Apollo* lunar program off the deck—is in reaction to the latest Soviet orbital flight.

The first step is due this week with the unexpectedly early scheduled launch of the *MA-4*, an unmanned *Mercury* capsule, into earth orbit. If completely successful, the shot will greatly enhance chances for a manned orbital flight in 1961.

At the same time, the space agency has decided to speed development of the *Saturn C-3* booster by holding a bidders conference within the next two weeks on its S-I first stage (M/R, Aug. 7, p. 13).

This means that the contract for the *C-3*—designed to lift a three-man *Apollo* spacecraft into manned flights around the moon—could be awarded by Oct. 1, also far earlier than planned.

All missile/space firms in the booster business will be invited to the conference. NASA officials said that it is likely that one firm will be picked to build the first stage of the *Saturn C-3* and the earlier version, the *Saturn C-1*.

• **Cautious go-ahead**—The decision to schedule an early *MA-4* shot followed a series of meetings at which Project *Mercury* officials reported that checks and tests of the *Atlas* booster and *Mercury* capsule were going well with all parts working smoothly.

MA-4 was first scheduled for the end of August or the first week in September, which allowed for the normal six-week period of testing the vehicle on the launch pad.

In an effort to save as much time as possible, NASA officials gave the go-ahead for the flight after about four weeks of checking.

With only two more shots definitely on the *Mercury* drawing board—an orbiting capsule with a monkey aboard and the manned orbital flight—it is still possible Project *Mercury* could come to a successful conclusion this year.

• **Highly iffy**—NASA officials admit privately that the success of such a timetable is doubtful, and that the manned orbital flight is still likely to go over to 1962.

Thus far, two out of three shots in the *Mercury* program using the *Atlas* booster have been unsuccessful. *MA-1* blew up on its pad and *MA-3* developed programmer trouble and had to be destroyed shortly after launch.

The success or lack of success of *MA-4*, therefore, will determine the *Mercury* timetable. If any problems develop in the flight, the shot will have to be repeated. The same procedure applies to the other scheduled *Mercury* shots.

• **Itinerary**—*MA-4* will use the capsule which was recovered after the aborted *MA-3* flight.

It will be lifted from its pad from Cape Canaveral by an *Atlas D* booster developing about 360,000 lbs. thrust. Its heading at launch time will be 70 degrees.

The sideboard engines on the *Atlas* will cut off 2½ minutes after launch; the main sustainer engine will shut down after five minutes.

According to the flight plan, the capsule will orbit the earth once and then land.

Its injection into orbit will occur five minutes after launch at an altitude of approximately 100 miles while passing over Bermuda. During the flight, the capsule will pass over Bermuda, Canary Is., North of Zanzibar, Indian Ocean, Australia, Southwest Pacific, Mexico, Texas, Louisiana, Alabama and Georgia.

The capsule will reach its apogee just off the west coast of Australia at an altitude of 150 miles.

Firing of its retrorockets will be automatic just off the west coast of Mexico. If the automatic signal fails to work, a backup signal will be sent from Wallops Is., Va.

As the capsule descends to its impact area off the coast of Bermuda, it will start encountering the atmosphere and resulting heat at an altitude of 50 miles. This will continue for about 20 miles.

Total flight time has been estimated at 90 minutes.

• **Different hatch**—Space agency officials said it has not yet been necessary to make any changes in this *Mercury* capsule as a result of the recent flight of Capt. Virgil Grissom in the *Liberty Bell 7*.

The officials points out that the capsule to be used, No. 8 in the *Mercury* series—is not fitted with the explosive hatch which caused so much trouble in the Grissom flight.

The *MA-4* capsule is fitted with the "bultog" hatch which was operational on all early versions of the *Mercury* capsule. The explosive hatch will be used on the capsule which the American astronaut will ride into space.

Space agency officials report that there is nothing wrong with the explosive hatch that a slight change in operating procedure will not cure. This involves leaving the firing pins for the hatch in until the astronaut is ready to leave the capsule.

The officials also said that no changes are planned in the recovery operation. About three Navy ships will be used and three helicopters will retrieve the capsule.

Main piece of equipment in *MA-4* will be the "man simulator." This will breathe in oxygen and exhale carbon dioxide as a human astronaut would do. It will create the same heat and humidity as a human in a test of the capsule's life support system.

Other equipment will include an earth-sky camera, another camera which will take pictures through the periscope, and one camera to film the instrument board. ⁂

Site Labor Dispute Procedures Streamlined

NEW PROCEDURES for handling union jurisdictional disputes at missile sites have been announced by the National Labor Relations Board.

The changes, designed to permit prompt hearings and reduce red tape, shorten to ten days the period between filing of any charge of unfair practices and the holding of a board hearing.

In the past, the procedure has often been spread over a number of weeks.

The speed-up will also be applied to defense establishments other than missile sites. ⁂

Machine 'Taught' to Recognize Sub Sounds

Raytheon's Cybertron equals human ability to sort out noises; remembers when it's 'punished' for its errors

A MACHINE that learns by its mistakes is already being taught to distinguish such phenomena as the "essence" of submarine sonar signals as well as expert human operators.

Called the "Cybertron" and developed by Raytheon Co., the machine is "educated" by being exposed to data in a specific field, modifying what it has already learned, and storing new data on its memory element. From each experience, the machine absorbs all it needs to know in seconds.

A smaller model of the machine, the K100, is working on military problems under contract with the Department of Defense. Cybertron K200, now in final stages of development, is a much larger learning machine designed to recognize speech sounds. When fully developed, Raytheon says, it will be able to recognize and type out all typical American word sounds by using its 192 learning elements.

The small machine (K100) uses punched tapes for learning, as well as for its memory element. A tape about one ft. long can store all it learned about dozens of cardiograms and sonar identification.

When the machine makes a mistake in learning, the teacher pushes a "goof" button. This results in "punishment"—making the machine re-evaluate its method and adjust its memory content. The teacher tells it nothing except that it erred. He can, if necessary, point out the correct answer. When it responds correctly, the K100 is rewarded by being allowed to continue operation uninterrupted.

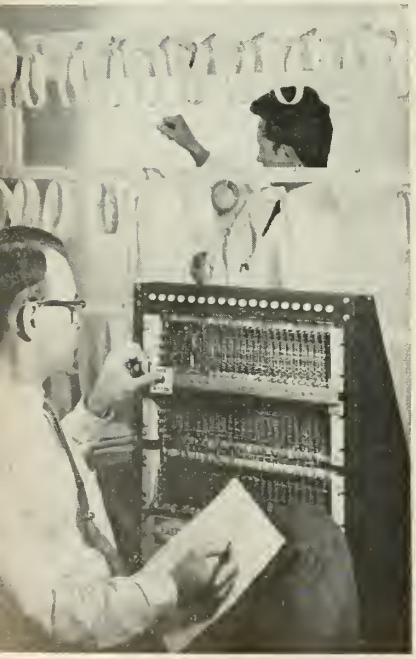
• **Learning process**—Here is a simplified example of the way the machine might be taught to recognize sonar signals from a submarine:

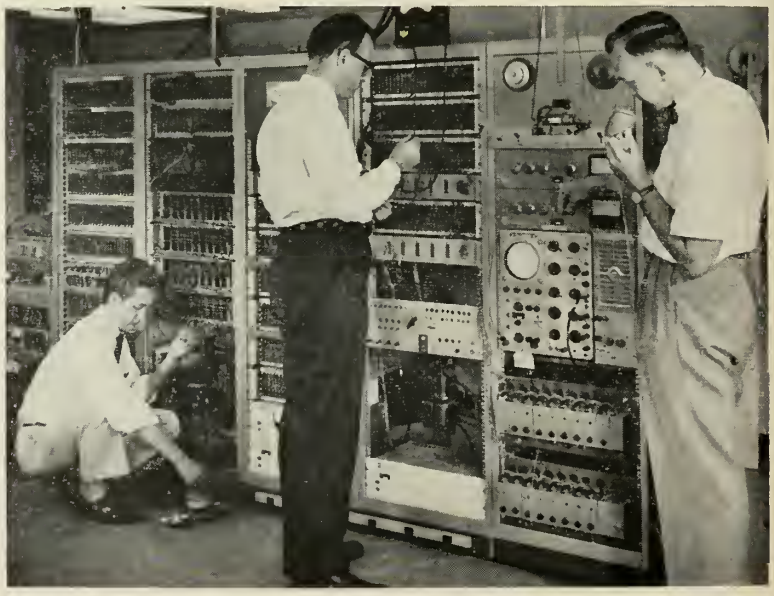
Sonar sounds—perhaps from a shrimp breeding ground—are fed into the Cybertron. The machine's memory drum is blank at this point and has zero correlation with the signal. It thus makes no response, which is correct.

Next, a submarine signal is sent through; there is again no response. Whereupon, the human instructor pushes the "goof" button; the Cybertron records the sonar signal on its memory. The next time such a signal passes through, the machine will recognize it for what it is.

The memory is now modified until it contains the essence of the class of submarine sonar signals. Suppose the signals from a surface ship are fed to the Cybertron. This signal contains some of the signature of the submarine signal. The machine calls it a submarine.

The human instructor points out the error to the Cybertron and the machine "subtracts" the surface-ship signal from the submarine signal already on the drum. In effect, then, the Cybertron now has on its memory a signal closer to the "essence" of submarine than it had before. Repeated lessons of this kind will teach the Cybertron to recognize underseas craft quickly and efficiently—at least as well as fully experienced sonar operators would do. ⁂





LEFT: *When Cybertron makes mistakes, human instructor "teaches" it by pushing "goof" button.* **ABOVE:** *Larger version is designed to type out speech sounds it "hears."*

Hughes to build SYNCOM . . .

NASA Likely to Order Fourth ComSat

NASA may become involved in a fourth active repeater communications satellite.

Plans are being drawn, MISSILES AND ROCKETS has learned, for a follow-on to Project *Relay*. If given a go-ahead—and this seems likely—NASA would invite bids from industry about the beginning of next year. Launchings of the new satellites would commence in late 1963 and continue through 1964.

Disclosure of the new NASA enterprise follows an announcement by the space agency last week that it had selected Hughes Aircraft Corp. to build an experimental synchronous ComSat similar to the Army's *Advent*. Last month, NASA made an agreement with American Telephone & Telegraph to launch two to four AT&T-developed experimental ComSats.

The four programs apparently will round out NASA's effort in the communications satellite field—at least for the present.

Although quite similar to the RCA-built *Relay*, the satellites in the proposed follow-on program will have some different characteristics. Among those presently being considered:

—A higher orbital altitude—perhaps 6000 miles—than Project *Relay's* altitude of 3000 miles.

—Two transponders (receiving and transmitting radio systems) may be included as part of the satellite equipment to increase its capacity to transmit messages. This will apparently mean an increase in the weight of the capsule.

—The inclination may be changed to increase the number of countries which can take part in communication experiments with the satellite. The elliptical orbit of Project *Relay* with its inclination of 48 degrees lends itself very well to transmission of messages on both sides of the Atlantic, but almost precludes messages from Pacific areas.

—The frequency of signals from the ground station to the satellites may be increased from *Relay's* 1725 mc.

• **Forerunners** — NASA's contract with Hughes calls for the building of at least three of the experimental synchronous communications satellites at a cost of $4 million.

The small, 50-lb. satellite would be a forerunner of what some experts believe will be the ultimate space communications system.

Such a so-called synchronous system involves placing satellites into an equatorial orbit approximately 22,300 miles above the earth. Because such satellites would travel at the same speed as the earth's rotation, they would remain over the same spot on the earth.

The Hughes satellites—dubbed Project *SYNCOM*—will be launched on three-stage *Delta* vehicles and be guided into a 22,300-mile-high orbit by an additional solid-propellant rocket attached to each spacecraft.

The first launching is scheduled for late 1962.

The satellite will not go into a truly stationary orbit because its trajectory will not be around the equator. Instead, it will be declined 33 degrees from the equator, resulting in an orbit roughly over the same longitude off the East Coast.

Although *SYNCOM* will not supply truly stationary satellites, the space agency said the project will provide "early experience" with an active communications system in a high-altitude orbit. At such altitudes, the effects of the Van Allen belts can be measured.

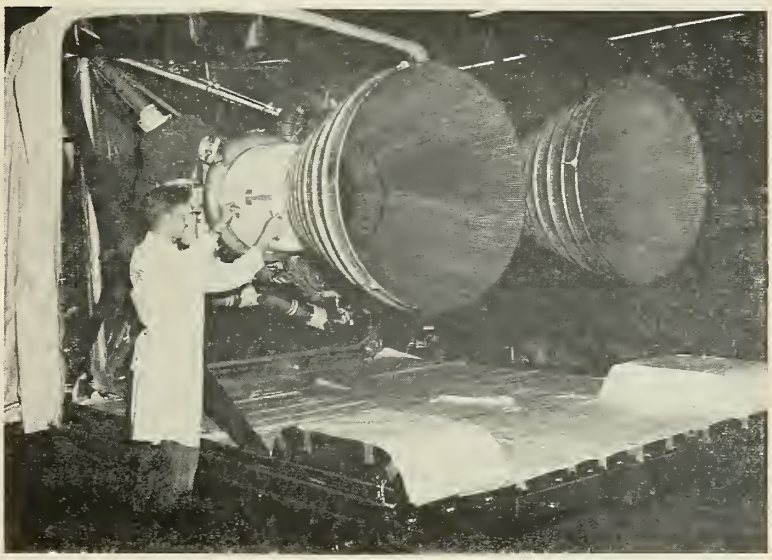
All of the other communication satellite projects are random-orbit low-altitude systems under which as many as 40 satellites are put into orbits about 3000 or 4000 miles high. The large quantity of satellites is necessary because the low altitude means that the sending and receiving period of each satellite is reduced appreciably.

SYNCOM satellites will be designed to relay telephone conversations and telegraph messages over near-hemispheric distances. They will not, however be capable of carrying television bandwidths because the frequencies used will be only 8000 megacycles from ground to satellite and 2000 megacycles from satellite to ground.

The *SYNCOM* program will be managed by NASA's Goddard Space Flight Center.

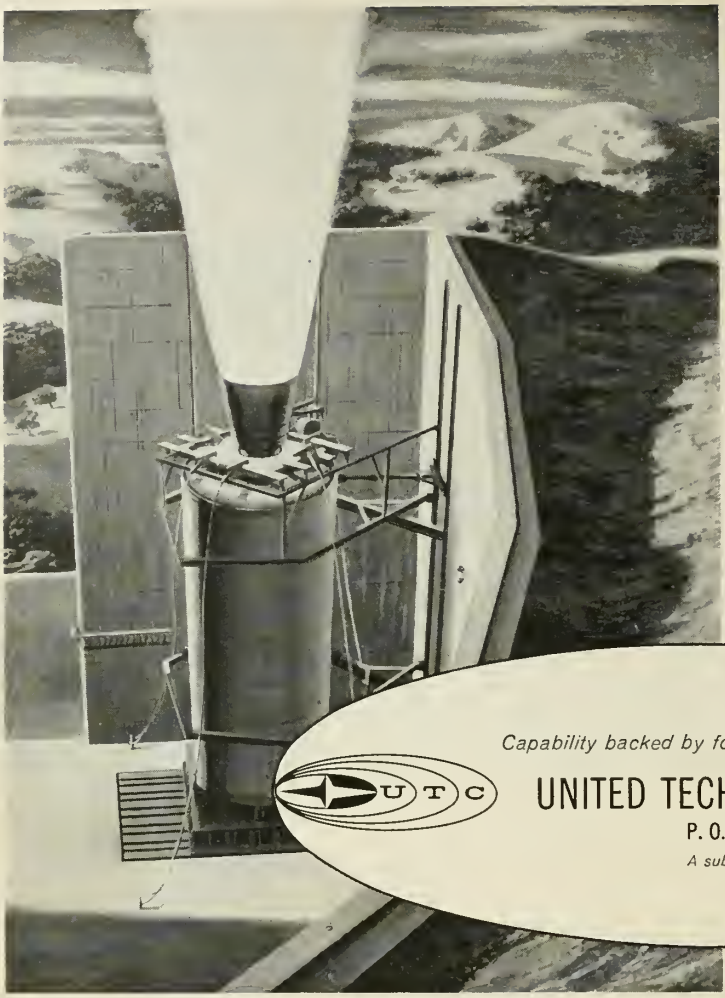
The Department of Defense, using Project *Advent* facilities under the direction of the U.S. Army Advent Management Agency, will participate by furnishing ground stations and performing communication experiments.

The Space Agency said that arrangements for joint NASA-DOD participation have been made in order to provide the most economical use of existing facilities and expand the national communication satellite research and development effort. ❖



First Production Engine for Titan II

FIRST-STAGE ENGINE for Air Force's Titan II gets final packaging before shipment from Aerojet-General's Sacramento plant, where it was designed and developed.



Left: Test-firing of large, flight-weight solid propellant rockets at UTC Development Center is important phase of multi-million pound thrust booster development program.

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Investigation of design criteria for metallic and nonmetallic rocket cases, nozzles and component hardware.

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Positions currently available in these and other areas:

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- Polymer chemist
- Plastics chemist

All qualified applicants will receive consideration for employment without regard to race, color, creed or national origin.

Circle No. 7 on Subscriber Service Card

Technical Countdown

PROPULSION

AF Concerned Over Propellant Safety

The Air Force is worried over the lack of sufficient high-energy liquid propellants for safety testing—with particular accent on large-scale toxic vapor and spill tests. Proper safety provisions are now being estimated; the Air Force would like more thorough testing. The need for these studies was tragically illustrated recently when an AF technician died and three co-workers were injured by gaseous nitrogen which leaked from a storage tank at an *Atlas* missile launching site.

ASTRONAUTICS

Soviet Telescope Being Readied for '62

A new Soviet radio telescope—the second largest in the world—according to the Russians—is due to begin operating at its site on the river Oke next year. Essentially a cross-shaped antenna formed by parabolic cylinders, the telescope was designed to solve the problem of the optimum correspondence of the sensitivity of the radio telescope with its resolution. The total geometric area covered by the telescope is 80,000 square meters; each of the parabolic cylinders is one kilometer in length and 40 meters wide.

Orbiting Repairmen to be Gyro-Stabilized

A free-floating, orbital space worker will be equipped not only with rocket propulsion devices to move him around in space but also with an unrestricted, free-floating mass to provide a comparative reference between his movements and forces being exerted on a surrounding structure. Four basic maneuvers would be required, according to a recent WADD report: rotation to proper flight path, translation between desired positions, rotation during arrival at a work station and stabilization in that final position.

ADVANCED MATERIALS

Air-Stable Titanium Powder Produced

Consolidated Astronautics is preparing to market an air-stable titanium metal powder which, unlike previous titanium powders, is not highly reactive with air. The stabilized form is produced from a film of titanium suboxide, only a fraction of a micron thick, to protect the balance of the pure metallic titanium particle against its normal affinity for the oxygen of the air.

Automation to Speed X-Ray Crystallography

A new technique—developed by Dr. S. C. Abrahams of the Bell Telephone Labs—should significantly accelerate research into the atomic structure of crystals. The new X-Ray diffraction process—called PEXRAD for Programed Electronic X-Ray Automatic Diffractometer—feeds data readings from the crystallographic experiment to a high-speed, general-purpose digital computer which correlates the information, corrects for experimental factors, and prints out crystallographic data in a convenient form for analysis.

Facilities to Produce Beryllia

Facilities in the New Jersey plant of the National Beryllia Corp. have been installed to allow the company to supply high-purity beryllia and alumina shapes metallized and plated on one or more surfaces, printed circuits on beryllia or alumina, and brazed ceramic-to-metal assemblies. Hydrogen furnace brazing will be used, so that customers can do their own high-temperature brazing to main assemblies.

ELECTRONICS

Pattern Recognition Device Under Study

The Air Force's Aeronautical Systems Div. at WADD has awarded a contract to the Laboratory for Electronics to "perform research on a self-organizing pattern recognition device." Essentially duplicating the actions of the eye in focusing an object on the fovea, the system will comprise a pickup—a mosaic of photocells capable of redirecting its movements in response to commands from within the recognition device. It is expected that the device will be useful in recognition of complex patterns such as handwriting and cloud formations.

Isotope Electrodes for Fuel Cells Revealed

Electrodes treated with radioactive isotopes have produced a marked decrease in polarization—permitting a current density of 150 ma/cm^2 to be sustained for extended time periods. Designed by Yardley Electric Corp., the fuel cell electrodes—made of sintered porous silver—permit construction of a simplified fuel cell more resistant to environmental stresses than those previously designed.

Maser Light Amplification Measured

In an experiment designed to observe and measure the light amplification of a pulsed ruby optical maser, scientists at the Bell Telephone Labs have observed a light amplification factor of two. Previously it had been difficult to distinguish the coherent maser light from the natural fluorescent light of the maser. This problem was solved by using a ruby maser oscillator to generate light which was so bright that the amount of fluorescence from the amplifier ruby was comparatively small. With more precise experimental set-ups and greater temperature control, even greater amplification is expected.

SUPPORT EQUIPMENT

AMR Tracking Capability Being Updated

A unique conical-scan feed now under development will be used to modify Atlantic Missile Range tracking antennas to provide complete coverage of the 100-1000 mc frequency band. The new broadband feeds—to be installed on existing 60-ft. TLM-18 antenna at Canaveral and down-range stations—are being built for AFMTC by Dynatronics. A bonus capability of the feed is its ability to cancel unwanted modulation of telemetered signals caused by missile roll and spin.

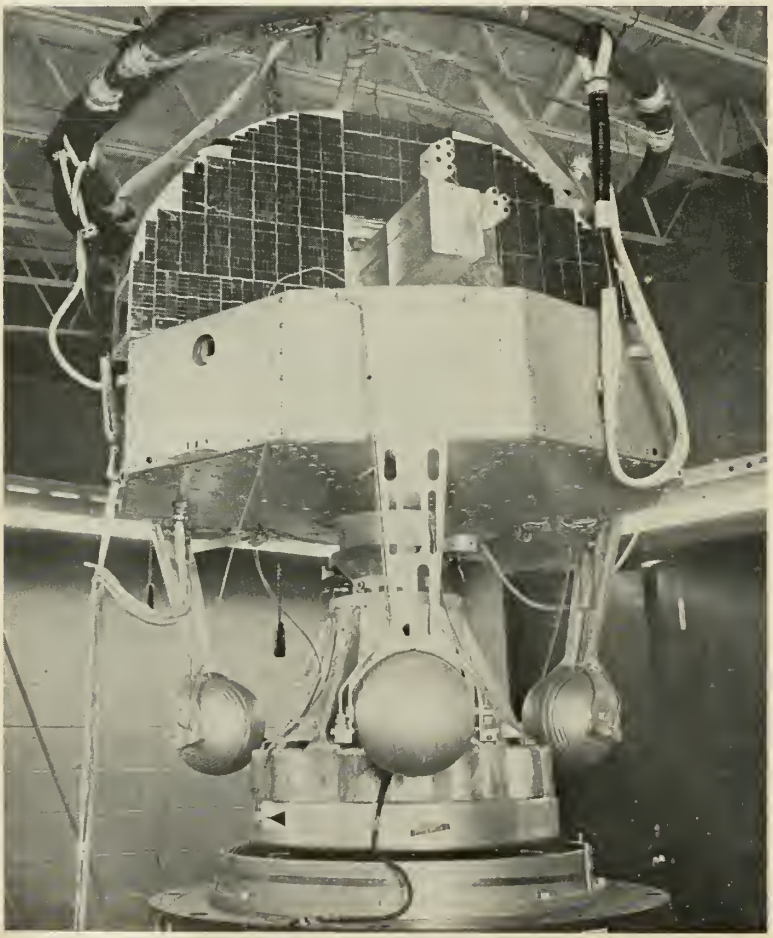
APL Develops Tiny Electrical Meter

An extremely low-power-meter—developed by engineers at APL for the submarine testing program of the *Polaris* missile system—is capable of checking the most sensitive explosive bridgewire circuits without fear of igniting the charge. Generating an extremely low current by the light of two small "grain-of-wheat" incandescent lights shining on a silicon photocell, the meter can measure resistances in the order of 0.1 to 10,000 ohms. New versions of the system are being developed for checking warheads, transistorized circuits, and special missile launching functions.

OSO Will Eye Sun's Center to Start

NASA to put maximum possible number of experiments aboard Goddard satellite; launch may mark man's first aiming of instruments from above atmosphere at precise area

by William Beller



GODDARD'S S-16 SATELLITE undergoing environmental test at Ball Brothers, Boulder, Colo. The two clusters of "eyes" mounted on the pointing instruments—which intersect the fan-shaped solar-cell array—are sensing detectors for positioning the S-16. The Medici-like balls contain nitrogen gas for attitude-control jets.

EARLY THIS FALL an instrumented satellite is to be launched into a 300-mile orbit by a *Thor Delta* to start a systematic study of the sun.

Swinging in a near-equatorial plane and pointing its primary instruments at the sun's center, this *Orbiting Solar Observatory (OSO)*—or *S-16* satellite—will collect data which will be correlated with terrestrial effects observed at ground stations.

Out of this work may come an understanding of the fundamental nature of the sun. Given this fuller basic knowledge, we would then have little need to examine solar symptoms—such as the ionosphere, Van Allen belts and auroral displays—in order to establish the nature of the sun.

• **Shot-gunning the sun**—Sun-earth relationships probably excite space scientists today more than any other area of investigation. This may be so because among all of the space sciences —which today are expanding at about the same rate as the nuclear sciences did after World War II—those dealing with the sun clearly can yield the most practical results.

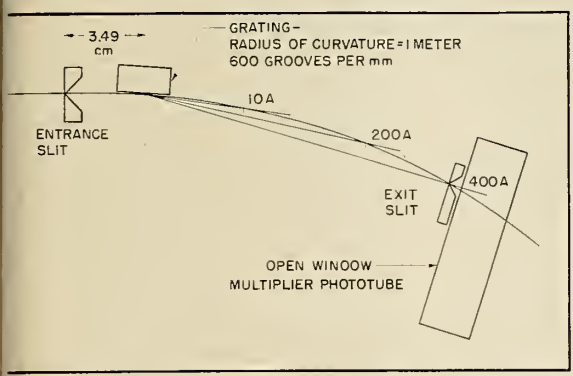
For example, at the last meeting of the International Union of Geodesy and Geophysics, in Helsinki, it was shown that the amount of ozone in the upper atmosphere varies with solar activity. Scientists have long felt that the ozone content has a strong effect on atmospheric circulation and weather disturbances in the lower atmosphere. Thus, one of the solar mechanisms which churns up our weather may have been revealed, and probably will be used in future weather studies.

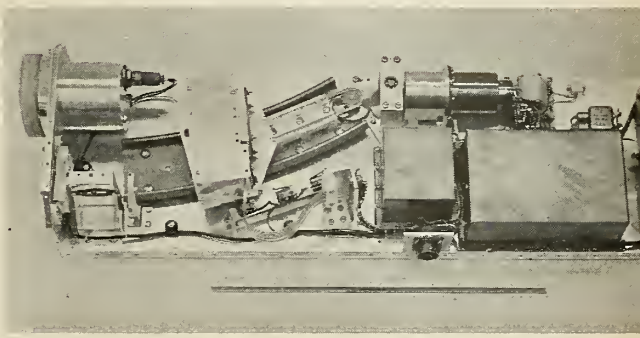
Furthermore geophysical research in general gets its fundamental inputs from solar data. And there are the solar effects on radio communications, magnetic storms and Van Allen belts—well known but little understood.

For all of these reasons, scientists at the National Aeronautics and Space Administration's Goddard facility—where the *S-16* is being monitored—are loading the satellite with as many different scientific instruments as it can efficiently carry.

• **Pointing at a quiet sun**—The *S-16* is being sent up chiefly to collect information on sun spectra in the ultraviolet and X-ray bands. For the first

Search for Basic Solar Knowledge





X-RAY SPECTROMETER for S-16 will use a grazing incidence concave grating of one-meter radius of curvature. A wavelength interval of from 10 to 44 Angstroms will be covered by a mechanical scanning system. Over this wavelength interval the resolution will be about one Angstrom. The instrument will be about 3 x 8 x 24 in., and weigh less than 20 lbs. It is planned to use an open-windowed multiplier phototube utilizing a tungsten photocathode for the detector.

time, these data will be gathered during a predicted quiet period—so that comparisons may be made when the sun is more active.

These experiments require that certain scientific instruments be pointed at the sun's center to an accuracy of one minute of arc. Hence, the *S-16* comprises two sections: a spinning, wheel-like structure to give stability, and on top of this a sun-seeking structure containing the pointing instruments.

Another important reason for launching the *S-16* is to test the performance of the sun-pointing structure. If the experiment succeeds, this will be the first time that man has been able to aim his instruments precisely at a given area—whether sun, star or any other body—from a point above the earth's atmosphere. The advantages of intensive area investigations are obvious.

If the *S-16* fails, it has a backup in the *S-16A*. Then, in about a year, the launching of *S-17* will initiate a second-generation *OSO*.

Only a few details have been disclosed about the *S-17*. The men mainly responsible for *OSO* designs are Laurence T. Hogarth, Goddard's project manager for the orbiting solar observatory program; and Dr. John C. Lindsay, associate division chief of Goddard's space sciences division.

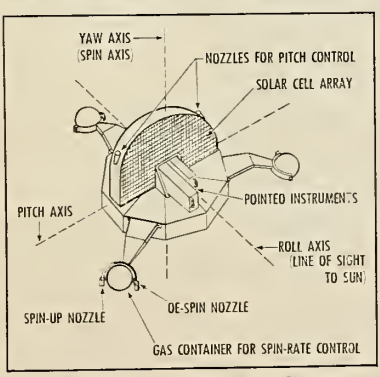
They say that the *S-17* will be doing much the same work as the *S-16*, but with one important modification: on command, the *S-17's* pointing instruments will scan the sun to give an image something like a television picture. The raster, made up by horizontal traces one minute apart, will be 40 minutes square. (The sun's diameter is 32 minutes.) This technique is expected to yield an integrated picture of some of the solar radiations.

• **A solar program**—The overall study of the problems of solar weather and its terrestrial effects was outlined by Dr. Homer E. Newell, National Aeronautics and Space Administration's deputy director of space flight programs.

First, Newell says, we must study the sun's surface by instruments such as those being put into *OSO's*.

Next, "we must send space probes into the interplanetary regions to detect the changes produced in the interplanetary gas as clouds of solar particles sweep across the space between the sun and the earth." *Pioneer V* has already found some answers to this part of the problem; and the *Ranger* series of spacecraft will be carrying instruments designed to get more of the answers.

Third, "we must measure the magnetic field of the earth and the changes in the properties of the atmosphere, over long periods of time, and correlate the observed effects with solar activity." He pointed out that these observations will be made by instruments mounted in *Orbiting Geophysical Observatories (OGO's)*. A special satellite for these purposes, to be launched within a year, will in effect be a forerunner of the *OGO's*.



SCHEMATIC of Orbiting Solar Observatory.

• **How OSO works**—The overall height of the *S-16* is 37 inches, and its total weight is about 440 lbs. Its hoped-for active life is six months. The satellite was designed to make maximum use of the payload volume of the *Thor Delta* launch vehicle.

Thus, the wheel diameter of 44 inches is the largest allowed by the *Thor Delta's* shroud. Three Fiberglas spheres filled with pressurized nitrogen gas for the spin-control system are mounted on arms hinged to the wheel. During launch, these arms are folded down around the third-stage motor—giving the satellite the appearance of a Medici coat of arms.

After payload separation, the nitrogen tanks are extended outward, thereby increasing the *S-16's* diameter to 92

(Continued on page 36)

Next Transit Orbit to be Near Perfect

Navy-ARPA satellite system being modified, chiefly in Able-Star 9 vehicle, to insure even greater accuracy than that of Transit IV-A

by John W. Herrick

LOS ANGELES—When *Transit IV-B* is launched next September, it is expected to achieve the most nearly perfect circular orbit of any satellite ever launched.

Transit IV-A attained an orbital eccentricity of .007, but the project's engineers are talking in terms of increasing this accuracy by an order of magnitude of at least 1.5.

Most of the changes for the future *Transits* have been made in the *Able-Star 9* vehicle. Evolutionary but extensive, they are designed to increase orbital accuracy by extending the range of positive ground guidance control.

• **New guidance**—A major switch in *Able-Star 9* is the use of Bell Telephone Laboratory's Series 600 radio-command guidance system to replace the Space Technology Laboratories' guidance components used in past *Able-Star* stages.

The STL autopilot system in *Able-Star 1* through *8* was slaved to a programer which operated through *Able-Star* first engine cutoff (SECO 1) and the coast phase. A flight-path error, detected by tracking radar, was corrected by a ground command to the appropriate autopilot gyro. The program could be modified at any time up to SECO 1. During coast, the autopilot gyros could be torqued to provide pitch programing and some yaw corrections.

One disadvantage of this technique was that the required corrections for *Able-Star* could exceed guidance system and autopilot capabilities. A second disadvantage was that the corrections consumed extra propellant—limiting the vehicle's payload, among other things.

Use of the new BTL radio-command guidance unit provides trajectory control of the *Thor* booster by supplying an input to the *Thor* autopilot gyros through the stage interface.

The booster now can be guided by ground command to a more accurate position in space prior to booster engine cutoff and stage separation. This change minimizes the amount of correction that must be applied to *Able-Star* flight path.

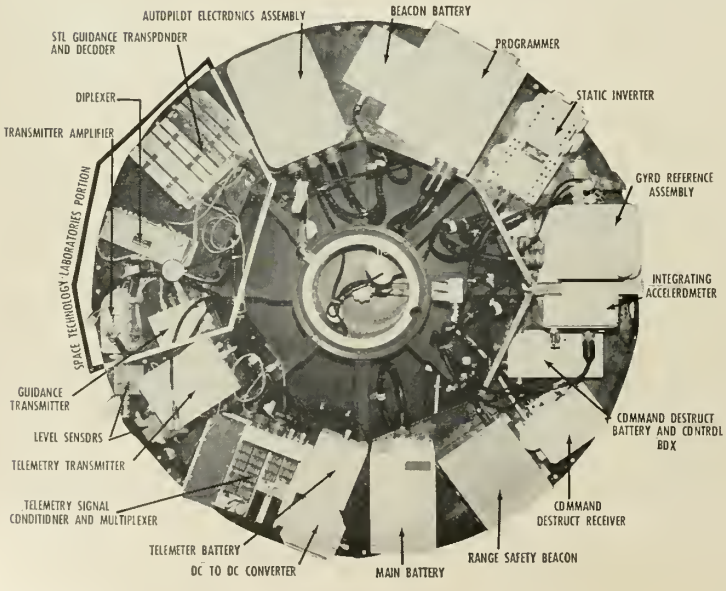
This fall, for the first time in the *Thor-Able* series, the entire launch vehicle will be guided from the time of acquisition—about 5-10 sec. after liftoff—through separation of *Able-Star* from the Douglas booster, and on through initial operation of *Able-Star* engine to the time of first cutoff of the engine.

New components designed, fabricated and packaged by Space-General Corp. will control *Able-Star* attitude through coasting flight, program the restart sequence, control the flight path during *Able-Star's* second propulsion phase, and determine final thrust cutoff (SECO 2).

• **Lighter and lower-powered**—The modifications to *Able-Star 9* include a Space-General-improved autopilot, programer, accelerometer, DC/DC converter and a completely rebuilt and repackaged telemetry system. The components will perform essentially the same functions as the earlier system, but they are lighter and require less power.

The new programer timer design is solid-state. It uses battery power only, and provides a switching capability of 50% more functions than the previous design. The former timer was driven by a 400-cycle motor—necessitating an AC power supply. The new timer is lighter and more reliable. Time accuracy has been improved by an order of magnitude of five.

The modified accelerometer system uses the same sensing element found in previous *Able-Star* vehicles—basically a pendulum mass. Accelerometer DC out-



Details of the Transit IV-B instrumentation.

put controls the frequency of an oscillator, thus changing mass displacement to AC signals.

Able-Star velocity or acceleration will be determined by "counting the cycles" by means of digital electronics. The new accelerometer will also be used to measure velocity during the first *Able-Star* engine firing—a function not included in the earlier systems.

The previous functions—to control engine restart and second thrust cutoff by determining when preselected vehicle velocities are reached—are to be continued. The latter function is critical in the *Transit IV-B's* capability to achieve the most accurate orbit possible. Redesigned accelerometer components are said to provide greater accuracy and reliability without any increase in accelerometer size.

The DC/DC converter boosts 28-volt DC battery power to an undisclosed higher voltage for telemetry.

The new telemetry system incorporates two commutators in place of the single one used previously. CW channels have been increased from nine to 14. The "extra channels" will be used for additional measurements such as tank pressures and vibrational forces.

STL will supply a C-band radar beacon for *Able-Star 9,* to aid in orbit determination of the expended stage. The beacon also permits interrogation of the guidance system after it is in orbit, to obtain information of possible use in future designs.

The single-horn antenna has been replaced by a dual-horn installation to aid ground tracking of the orbiting *Able-Star.* New design will improve the radiation pattern for pickup by worldwide stations regardless of vehicle rotation or attitude. The original one-horn antenna was designed to deliver the best pattern back to Cape Canaveral receivers as the stabilized vehicle approached its radio horizon.

• **Clean break**—Two seven-lb.-thrust retrojets have been added to the upper end of *Able-Star 9* to ensure clean separation from the payload.

No changes have been made to the *Able-Star* propulsion system other than installation of anti-sloshing baffles in the two propellant tanks. These were first used in *Able-Star 8 (Transit IV-A)* when previous launch data indicated a strong probability that propellant sloshing caused a dynamic coupling between the fluids and sensor elements of the guidance and autopilot systems.

Space-General estimates that the weight saved in *Able-Star 9* improvements closely equals the weight of the additional beacon, antennas, retrojets, guidance package and other new components. Cost of the changes is claimed to be less than the price of one *Able-Star* vehicle. ⁂

First Advent to Test Controls

FIRST LAUNCHING of *Advent* communication satellites with *Atlas-Agena* boosters will check out advanced attitude and orbit control systems.

A three-axis inertial-wheel system, backed up by stored-gas attitude jets, will keep transmitting and receiving antennas aimed at earth stations. Knowledge gained from a similar Space Technology Laboratories' attitude control system in *Orbiting Geophysical Observatory (OGO)* is being applied to *Advent* design.

As in *OGO, Advent's* two large solar paddles will be kept oriented to the sun by sensor devices on paddle shafts, although the main body will make one complete revolution, with respect to inertial space, in each orbit.

The cold-gas jets—fed from high-pressure storage containers—will be used only for attitude maneuvers beyond the capability of the inertial-wheel system. For long-duration operation of a controlled satellite in space, electrically driven inertial wheels appear to be the best devices. Although slow in accomplishing a rotational change, they operate relatively continuously for months without running out of power.

• **Initial objectives**—First *Advent* program phase will involve several low-altitude inclined satellite launchings. Objectives of this program will be to space-prove propulsion, attitude control, tracking, telemetry and command subsystems. STL, in providing systems engineering and technical analysis services, will also orbit control equipment, environmental sensors, and communications equipment.

Some of the equipment to be space-tested will be provided by General Electric, prime contractor for *Advent.* The full-scale research and development effort is the responsibility of the Army's *Advent* Management Agency (Ft. Monmouth, N.J.) under command of Brig. Gen. William A. Thames.

The *Advent* program will determine the feasibility of a multichannel microwave global space communication system for strengthening military communications. The system will place communications satellites in 24-hr. circular equatorial orbits to operate as radio relay repeater stations. Success of the *Advent* program depends upon reliable attitude control for antenna aiming, accurate orbit control to maintain exact position over a fixed point on earth regardless of perturbing forces, and dependable continuous operation of unattended microwave electronics in the space environment.

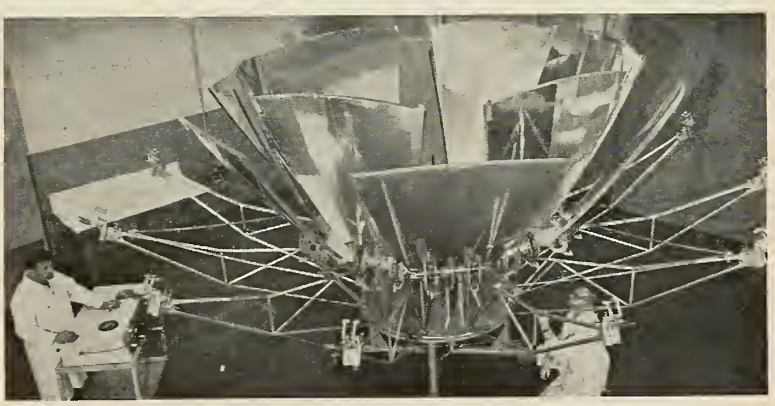
The last two vehicles in the NASA *Atlas-Centaur* development test program will be made available to place advanced *Advent* satellites in 24-hr. orbits.

• **Shifting emphasis** — The second phase of the *Advent* program stresses a different order of certain objectives and includes new areas of testing.

Principal objectives of the second phase will be to space-test attitude and orbit control, tracking telemetry, command, power, microwave communications, temperature control and environmental sensors.

To complete the *Advent* feasibility program, *Atlas-Centaur* vehicles will boost operational-type satellites into equatorial orbit at the fixed-position height of about 22,000 mi.

Construction of communication terminals is now under way at Camp Roberts, Calif., and Ft. Dix, N.J. A Navy ship will also provide a mobile receiving and transmitting station. ⁂



Collapsible Solar Mirror

PROTOTYPE petal-cut parabolic mirror developed by General Electric's MSVD for experimental solar thermionic power system unfolds to 16-ft. diameter. Equipment is going into GE's Phoenix, Ariz., solar test facility.



For early '62 firings . . .

Kwajalein's Zeus Test Facility Near



Project Press construction at Roi Namur approaches half-way point; anti-ICBM missile to face wide range of targets

THE ARMY Corps of Engineers has completed some 70% of the $45 million to $50 million *Nike-Zeus* construction program on Kwajalein.

Meantime, nearly half of the $20-million construction program on near-by Roi-Namur for Project *Press* also has been completed.

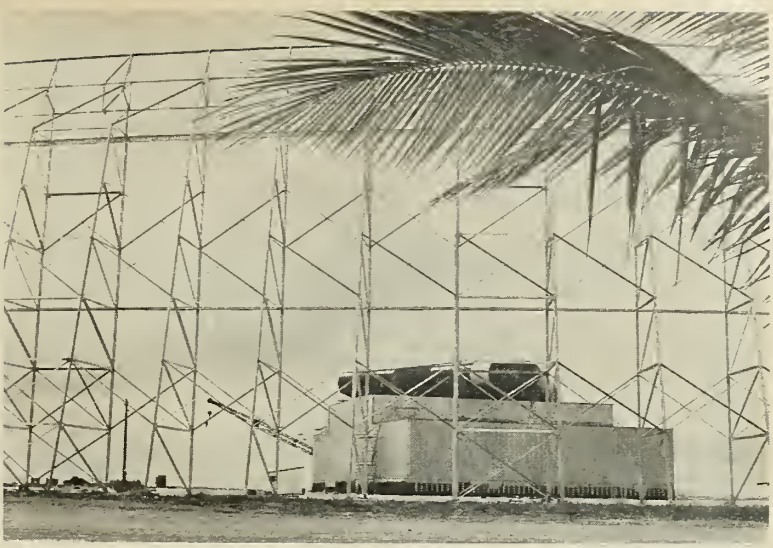
All buildings for the huge *Nike-Zeus* test facility in the Western Pacific are expected to be placed under contract by October. All buildings for Project *Press* are expected to be under contract by next month.

Some 1150 construction workers are currently employed on the two projects. The monthly payroll is running between $450,000 and $475,-000.

← *RECEIVER BUILDING is readied to house the huge Zeus Acquisition Radar (ZAR).*



NERVE CENTER of the Zeus system is the missile battery control building, with towers for tracking radar antennas.



SIXTY-FIVE-FT.-HIGH shielding fence surrounds the Zeus Acquisition Radar Transmitter to protect personnel working in the area from its high power.

Completion

Most of the major installations for *Zeus* are already completed or nearing completion. The first tests of *Zeus* antimissile missiles against ICBM's launched from Vandenberg AFB are scheduled for early next year.

The tests at Kwajalein will check out the entire *Zeus* system for the first time. They will be used not only to prove the system but to bid for production money from the Kennedy Administration.

• **Varied targets**—In the tests, *Zeus* missiles will be launched against regular *Atlas* warheads and special warheads designed to present the *Zeus* system with decoys and multiple targets. *Zeus* missiles also are expected to be launched against electronic point-in-space targets.

Project *Press* — Pacific Range Electro-magnetic Signature Study—is a part of the *Project* Defender program which is aimed at seeking new means of combating incoming ICBM warheads. *Press* equipment will study ICBM launchings from the West Coast.



FRESH WATER for the vast Kwajalein complex is provided by 15 1-million-gallon fresh water tanks filled from a basin at the airstrip.



BOARDINGHOUSE for 300 civilians working on Project Press is a Navy APL Ship. Some 300 additional civilians eat aboard and sleep on shore.

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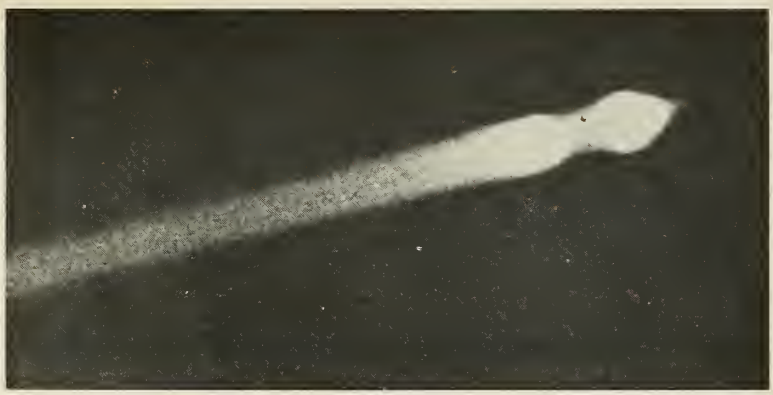
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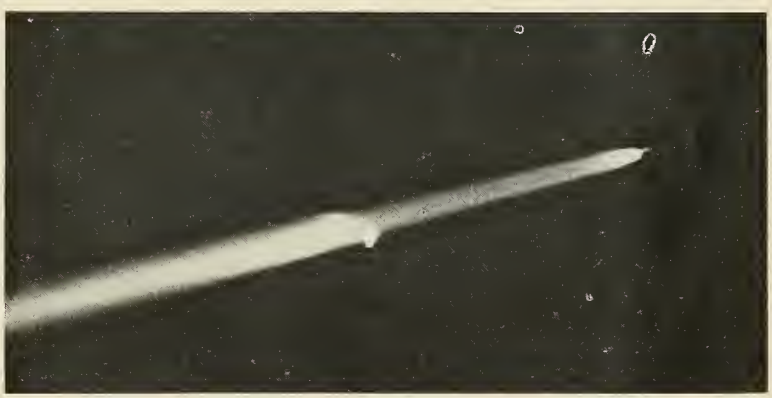
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First photos . . .

In-Flight Minuteman Separation Sequence









HIGH-SPEED photo sequence caught this first-stage separation and second-stage ignition of the full-scale first *Minuteman* flight Feb. 11, 1961.

Taken while the three-stage ICBM was soaring about 45 miles into the sky, the top photo shows the moment of separation and ignition, with the first-stage engine still burning. In the next picture, the first stage has started to fall away; and in the third photo it is beginning to tumble while still in the exhaust path of the second stage. In the bottom photo, the second and third stages head downrange—where they also separated and ignited with similar precision.

Next shot of the 5500-mile solid-fueled missile—expected in a few weeks—will be the first from a silo at full range.

The photos in the sequence here were taken with a 70 mm ROti optical tracking camera using a 500-in. Perkin-Elmer lens.



Princeton Climate Spurs Research

Major Space Age R&D coming from campus where Goddard began serious rocket work; private labs thrive nearby

by Reed Bundy

PRINCETON, N.J.—"Almost a Utopia" is the way one rocket research professor describes it.

The quiet town of Princeton has been a leading academic community for more than 200 years. In this century, it became in addition a residential mecca for business and professional men with offices in New York and Philadelphia, both an hour's train ride away.

Now it has taken on a third dimension, as one of the nation's leading centers of missile/space research. Many millions of dollars have becn invested by government and industry in basic and applied Space Age R&D at the university and more than a dozen industrial facilities in the immediate area.

At the university, research funded largely by the military services has produced much of the basic know-how of American propellant technology. It has also supplied invaluable knowledge of gas dynamics—including the only available performance data on speeds from Mach 15 to Mach 20.

Under the leadership of Dr. Martin Schwartzschild of Princeton, the first successful attempt to lift a telescope above the atmosphere by balloon—Project *Stratoscope I*—was carried out. Initial flights of *Stratoscope II*, carrying a telescope with a larger aperture, are scheduled for later this year, again under Schwartzschild's direction.

The ultraviolet-satellite study *Orbiting Astronomical Observatory No. 3* in the NASA program is being directed by Professor Lyman Spitzer, Jr., of the university's observatory (M/R, June 26, p. 26).

Spitzer also directs the Plasma Physics Laboratory (formerly Project *Matterhorn*), Princeton's major effort to achieve a controlled thermonuclear reaction, which is being pursued under a cost-reimbursed contract between the university and the Atomic Energy Commission. The 10-year-old program has cost $55 million so far.

The most spectacular Space Age contributions in the industrial community have come from the Radio Corporation of America. At its big laboratories in Princeton, RCA developed and produced the *Tiros* weather satellites. It will develop an experimental satellite for NASA's Project *Relay*. Earlier, it had a vital role in the *Score* and *Echo* programs.

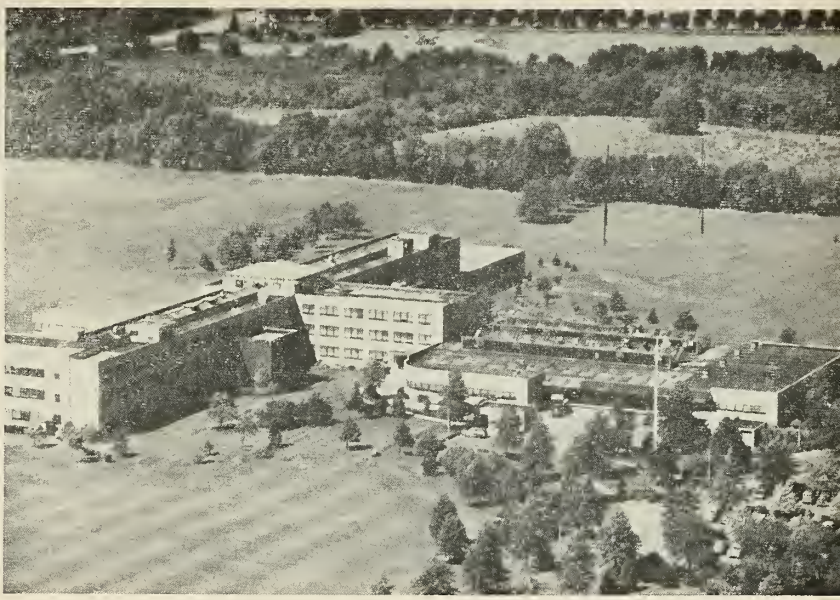
• **Goddard and Guggenheims**—All of this is especially appropriate because it was at the university in 1912 that Robert H. Goddard, during a one-year research fellowship, first began serious study of the possibilities of rockets. In a real sense, Princetonians feel that their town was the birthplace of America's Space Age.

There is another link between Princeton and Goddard. The Guggenheim family, which was Goddard's only substantial source of funds during his pioneering career, is also a financial mainstay of missile/space work at the university today.

Princeton recently announced that its Jet Propulsion Center will be expanded into The Daniel and Florence Guggenheim Laboratories for the Aerospace Propulsion Sciences. The next few months will see the beginning of construction of a new $300,000 laboratories building to broaden the work in jets, rockets, space flight and aerospace

LEFT: *Aerial view of Department of Aeronautical Engineering. Gas Dynamics Lab is in foreground (note helium bags).*

RIGHT: *Biggest industry facility in area is RCA's Sarnoff Center, now adding big space environmental center.*



propulsion which has been conducted at the Center since 1948.

The Center was one of the world's first institutions to offer graduate education and research in jet propulsion, rockets and astronautics. In the last 12 years, it has given graduate training to more than 200 specially qualified young scientists and engineers—of whom 56 were Guggenheim fellows. Many of these now hold key positions in U.S. missile/space programs. The Laboratories will now offer a minimum of four such fellowships annually.

Together with the Gas Dynamics Laboratory and the Applied Aeronautics Division, the Center forms the Department of Aeronautical Engineering. The Department is located next to the Plasma Physics Lab at the James Forrestal Research Center, on U.S. Route 1, east of the town.

• **Jet propulsion**—The faculty of the Jet Propulsion Center consists of the Robert H. Goddard Professor, Dr. Luigi Crocco; Professor Martin Summerfield; and Associate Professors Irwin Glassman and Jerry Gray.

Dr. Crocco is one of the world's foremost authorities on both jet propulsion and gas dynamics, and was a pioneer in the field, having worked on powder and liquid propellant rockets under the sponsorship of the Italian General Staff in 1928-30, while an undergraduate at the University of Rome.

He received a leave of absence from Rome in the fall of 1949, to accept an appointment as Visiting Professor at Princeton. He received a permanent Princeton appointment in 1953. Since his arrival in '49, he has occupied the Goddard Chair, established by the Guggenheim Foundation.

Crocco first published the results of his early work on problems of high-speed heat transfer in 1931. He then carried out an investigation of the possibilities of high-speed wind tunnels which contributed to the establishment in 1934 of the world-famous tunnel at the Guidonia Research Laboratory near Rome, one of the first ever built.

Later he worked with high-velocity aviation engines, aerodynamics, and after World War II as a consultant to the French War Ministry in the field of rocket propulsion.

His services as a consultant have been utilized in recent years by numerous U.S. corporations.

At the Jet Propulsion Center, Crocco has specialized mainly in liquid rocket combustion instability and related subjects and has, his colleagues say, "made it into a science."

The Center's chief expert on solid propellants is Dr. Martin Summerfield, who concentrates on such areas as steady-state burning ignition and parameters for programed control in flight.

Summerfield, who during World War II guided the development of a rocket engine for the X-1, first U.S. rocket plane, came to Princeton in 1949 as general editor of the university's pioneering publications program in high-speed aerodynamics and jet propulsion. He became a professor in the Department of Aeronautical Engineering in 1951.

A number of Summerfield's research reports have pointed the way to new developments in rocket technology. In 1947 he coauthored (with Frank J. Malina) a paper on "The Problem of Escape from the Earth by Rocket," and a few years later he wrote a publication on "Problems of Launching an Earth Satellite," a technical evaluation of engineering aspects of satellite vehicles.

In recent years he has concentrated on the fundamental problems of solid-rocket propellant combustion and on flame propagation mechanisms in gases.

Summerfield was formerly technical director of Project *Squid,* a program of fundamental jet propulsion research at nine universities which had its headquarters at Princeton. He has served on government committees dealing with rockets, combustion and fuels, and has been a consultant to several major companies.

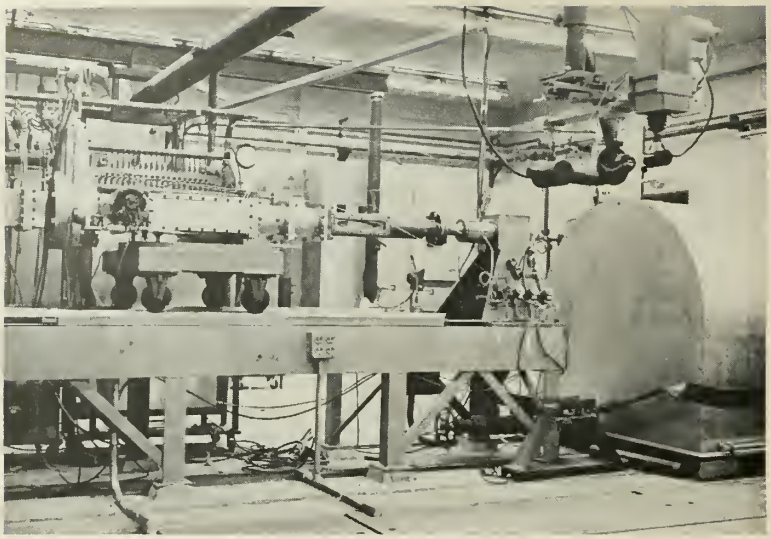
From 1945 to 1949, he was chief of the Rocket Research Division of the Jet Propulsion Laboratory at California Institute of Technology. Earlier, he was with Aerojet-General at Azusa, Calif., where from 1943 to 1945 he was Chief Engineer of the Special Project Department, directing research and experimentation in rocket development and production.

Summerfield is editor of the *ARS Journal* and for years was editor of *Jet Propulsion,* a now-defunct journal of the American Rocket Society. In 1954, he won the annual G. Edward Pendray Award for outstanding contributions to the literature of rocketry and jet propulsion. In 1960 he was elected to a third two-year term as a director of the ARS.

Cluster of Industry

Most of the industrial labs in the Princeton area are involved in electronics. These include: *ASCOP Div. of Electro-Mechanical Research, Inc; DODCO, Inc.; General Devices, Inc.; Princeton Div., Curtiss-Wright Corp.; Princeton Computation Center, Electronic Associates, Inc.; Princeton Electronic Co.; and RCA's David Sarnoff Center and Astro-Electronics Div.*

Missile/space research in areas other than electronics is conducted at: *AeroChem Research Laboratories, Inc. (propulsion); Aeronautical Research Associates of Princeton, Inc. (aerodynamics); FMC's Research and Development Center (propulsion); G. F. Bush Associates (scientific instruments); and McLean Engineering Laboratories (cooling devices).*



UNIQUE FEATURE of Gas Dynamics Laboratory at Princeton's Forrestal Research Center is helium hypersonic tunnel. Using helium instead of air for working fluid, it has been employed to test X-15 and other models at speeds up to Mach 20.

J. Preston Layton is program manager for Jet Propulsion. He negotiates the money contracts (which last year totalled about $800,000, including awards from all three military services and NASA), and controls expenditures.

• **Home-mixed solids** — "Our programs involve large sums, many people —and hazards," Layton says. "We make solids ourselves—solids with from 1000 to 2000 lbs. thrust—and students are exposed to them. There have been some explosions, but no casualties."

In each program, graduate students work with professors and research associates. "Nowhere else," Summerfield says, "is there this type of professor-researcher set-up. At (he named another well-known university with a jet propulsion laboratory) there is no faculty as such—work is financed by separate fees."

In Princeton's jet propulsion research program, by contrast, the work must originate at the Forrestal Center. Research results are published as theses, then must be suggested and accepted as the basis for further programs.

• **Gas Dynamics**—The university's unique Gas Dynamics Laboratory has three professors—Seymour M. Bogdonoff, Wallace D. Hayes and Sin-I Cheng—and an associate professor, S. H. Lam. The research manager is Indian-born Irwin Vas.

The 40-year-old Bogdonoff was responsible for developing the laboratory's facilities and has been in charge of its experimental program since it was begun with Navy backing in 1946. He has made pioneering contributions to supersonic and hypersonic aerodynamics, and is recognized as an expert in design and operation of subsonic and supersonic research apparatus. He is a frequent consultant to industry and the Air Force.

Bogdonoff came to Princeton's faculty after four years at the National Advisory Committee for Aeronautics (NACA) Laboratory at Langley Field, Va. During his years at Langley, he investigated in the Airflow Research Division, researched compressor blades, designed new cascade tunnels, and served for two years as assistant director of the Fluid and Gas Dynamics Analysis Section.

The Gas Dynamics Laboratory is the only one of its kind in the world equipped to simulate flight conditions at velocities ranging up to 20 times the speed of sound and at altitudes up to 150,000 ft.

The Lab, jointly sponsored by the Air Force and the university, is engaged solely in fundamental, non-classified research. Its continuing investigations in six high-speed wind tunnels have provided valuable test data on low supersonic speeds—and, the only available performance data on speeds from Mach 15 to Mach 20.

• **Helium tunnel**—These speeds are achieved in a hypersonic tunnel which uses helium rather than air as a working fluid. The technique was developed at the Lab some years ago. The helium tunnel can be run for as long as 10 minutes, compared to the milliseconds limit on other hypersonic tunnels.

• **Theory mated to testing**—Bogdonoff calls the university's scientific atmosphere "close to Utopia." He points out that unlike other universities that "splinter up" their scientists, Princeton closely couples theory and testing. "We earn our living by not believing theories," he says. "We make experiments to check them out."

Although the laboratory's research capability is available to all, it has consistently refused to make a long-range connection with any company. Hence, while it has made spot tests from time to time, it is not a "testing outfit," in the professor's words. And the testing it has conducted has been keyed to national defense—no testing whatever for industry.

The money for the Gas Dynamics Laboratory's $300,000 annual budget comes largely from two longstanding Air Force contracts, one from the Office of Scientific Research and one from Wright Air Development Division.

"Most of the money goes to the students in one way or another," Bogdonoff says. "The budget pays for building everything we have to build. About two years ago, another $300,000 was set aside to develop facilities and build capabilities. The University added a new wing on the laboratory; the Air Force provided the equipment for it."

Despite the feeling that funding should be "once removed" from industry, the Laboratory has excellent con-



TYPICAL OF RELATIVELY SMALL industrial facilities in Princeton community is campus-like building housing Princeton Computation Center of Electronic Associates, Inc. Company performs computing services for many other firms.

nections with industry. One student who had been an engineer for five years was supported by The Boeing Company while he worked on his master's degree at the lab.

The group of graduate students includes, in addition to Americans, a broad range of foreign representation. Among past or present students are young men from Europe, South America, Japan and Formosa.

• **Industry top dog**—RCA has by far the largest industrial research operation in the Princeton area. Its laboratories at the David Sarnoff Center on Route 1 have some 1100 employees. At the Astro-Electronics Division, in nearby Hightstown, there are another 500. Between them they do a multi-million-dollar missile/space business annually.

In general, the laboratories work on "blue sky" projects, while AED is more nearly tied to earth. AED designed, developed and built the *Tiros* weather satellites, for which RCA is prime contractor to NASA. Other AED-supplied hardware includes FM receivers and transmitters used in Project *Score* and the beacon transmitters which are the only operating part of NASA's Project *Echo*.

RCA is a one-tenth owner of Industrial Reactor Laboratories in Plainsboro, about four miles from Princeton, and utilizes IRL nuclear reactor facilities in problems requiring use of radioactive materials.

The company is well along with construction of an elaborate advanced space environment center at Princeton.

RCA has worked with the University on both *Stratoscope* and the controlled fusion effort.

• **The lures**—There are obvious dollars-and-cents reasons why large and small companies have set up R&D facilities here and continue to do so. Princeton is, as noted previously, halfway between New York and Philadelphia. It is not far from many major manufacturing plants. And there is still land available.

For researchers, there are deeper advantages in the extracurricular activities centered around the university, with the full opportunity for exchange of ideas that this affords. One example is the Princeton Section of the American Rocket Society, one of ARS's most active groups.

A much-appreciated feature of the scientific life is Princeton's library book exchange program, in which the numerous industrial libraries have joined with the university. This makes Princeton's giant (1.4 million bound volumes) Firestone Library available to the company scientist, and gives him access to libraries at each of the other research labs. ⌘

soviet affairs

By Dr. Albert Parry

A "rocket-drill" for mining

is described by K. Kostin in a recent issue of *Tekhnika—Molodezhi.* It is called SBO—for *stanok burovogo ognia*, or "installation of drilling fire." Its action is aimed downward or sideways into the ore. "The working tool is a gas stream with a temperature of 2500 degrees of heat," the author explains. "The stream's power is so great that the installation holding the rocket-drill had to be made extra heavy—36.5 tons. Otherwise the stream could have carried the whole installation skyward."

Oxygen and kerosene constitute the rocket-drill's fuel; water is an important auxiliary. The gas stream breaks the ore; the water forms steam which throws the broken ore up to the surface of the mining pit. The rocket-drill is used on extra-hard ores. "The harder the ore, the better—faster—is its drilling," Kostin reports. The rocket-drill has been built by Giprorudmash Institute at Krivoi Rog in the Ukraine, famous for its high-grade iron deposits and mines.

A compass for a space ship

was discussed by M. Volgin and M. Karev in an article entitled "Superconductivity Knocks at the Doors of Technology" in the May issue of *Znanie-Sila.* An aircraft gyrocompass is useless in rocketry, they say, because "friction in bearings, from which the gyrocompass is suspended, can distort its function." Space flights over long distances demand a gyrocompass which is virtually frictionless and is not influenced by the rocket ship's sharp turns.

The authors suggest that "magnetic qualities of superconductors be utilized" for such a cosmic compass. "It is clear," they write, "that if a superconductor pushes the magnetic field out of itself, the magnetic field will push the superconductor out. And if we place the superconductor over a solenoid creating the magnetic field, the pushing force will at a certain moment balance the metal's weight. The superconductor will be suspended with no support.

"And now imagine a superconducting little ball suspended over a magnet and somehow or other made to revolve. Since there will be no bearings involved, there will be no friction. And if we dye the little ball and aim a ray of light at it, the reflected ray will make it easy for us to judge the direction of the axis of the ball's revolution." Hence the future space-ship compass, working perfectly.

The authors declare that, since the first models of superconducting gyroscopes have already been built and successfully tested, the next step would be to experiment with them on rocket ships.

The Sputniks have met with no meteoroids

"in all their flights of many millions of kilometers," remarks V. A. Sokolov of the staff of the Academy of Sciences in his article "Phases of the Great Path" in the May issue of *Nauka i Zhizn'*. "Possibility of a collision with a dangerous meteorite is extraordinarily small, although it is not absent entirely," Sokolov asserts. He foresees special precautions against such collisions for future space ships, traveling over great distances. These would include a division of the rocket's cabin into several compartments, each to be hermetically closed off from the others in such an emergency.

Little danger from meteoroids

threatens future astronauts, according to Boris A. Mirtov, a candidate of the physics-mathematical sciences, interviewed in the June issue of *Tekhnika-Molodezhi.* It is true that "nearly 5000 tons of meteorite precipitation falls to Earth every 24 hours, and all this mass bursts into the Earth's atmosphere with a gigantic speed." Granted that "an encounter with large meteorite particles can be fatal to a space ship, since [even] a particle of 6 to 8 millimeters in size can pierce a 10-centimeter aluminum plate. Yet, fortunately, particles of such sizes are rare. It has been established that a sphere 1.5 millimeters in diameter, at the height of 100 kilometers above the Earth, can bump into a cosmic particle 1 to 2 millimeters in size only once in a century."

Goddard's OSO

(Continued from page 23)

inches. In this way, the satellite's axial moment of inertia is made considerably larger than either of its transverse moments, and stability is enhanced.

The entire third stage is spun up to 100 rpm prior to third-stage firing. After third-stage burnout and payload separation, the wheel's spin rate is reduced to 30 rpm and held there by the action of gas jets attached to the spherical tanks of nitrogen.

The spinning structure is composed of nine wedge-shaped compartments. Five of these are for scientific experiments; the other four are used by Ball Brothers—the prime contractor for the *S-16*—to house some of the electronic controls, batteries, and all of the telemetry system, radio command system and in-flight data storage system.

The stabilized, or top, part of the satellite holds a fan-shaped array of silicon solar cells in addition to the pointing instruments. This entire structure is connected to the rotating base by an aluminum shaft that passes through the center of the rotating wheel. This shaft is held in position by two bearings, one at the top of the wheel and one at the bottom.

The stabilized section is servo-driven by gas jets to yield complete azimuth control and limited elevation control.

Solar Observatory Experiments

Prime contractor—Ball Brothers
High-Resolution Lyman-Alpha Spectrometer
University of Colorado

UV and X-Ray Spectrometer; Low-Energy Gamma Ray Monitor
Goddard Space Flight Center

Soft Gamma Ray Solar Monitor
University of Minnesota

Hard Gamma Ray Solar Monitor
University of Rochester

Materials Experiment
Ames Research Center

Neutron Flux Sensor; Electron-Proton Analyzer
University of California

The system's power requirement call for about 25.5 watts. During daylight operation, the solar cells will furnish 29 watts. Nickel-cadmium batteries will give power during solar eclipse.

Goddard scientists emphasize that the *OSO's* are part of a national program in which many universities and institutions will engage. In turn, the data gained will be freely given to anyone, of any nation, who can make use of it. It is felt that this is the way in which a major program of studying the sun can be most effective. ⁂

letters

(Continued from page 7)

us no end. Even though it's been years since we cracked our college physics text—because if we did we'd no longer understand it—we seem to recall that what you gain in kinetic energy, going downhill, you'd lose going up that same hill. In fact, you'd come out even ONLY if there were no friction, windage, and other losses.

Why then, in addition to the sloshing problem you referred to, would ski-launching of missiles serve any useful purpose?

Lucien R. Greif
Greif-Associates, Inc.
New York

Joint Switch

To the Editor:

I noted with interest the item titled "Fast Switch" in M/R's July 17 COUNTDOWN (reporting that four Dynatronics engineers cut a gear box out of an Eglin AFB antenna and flew it to San Nicolas Island off Point Mugu to fix a *Tiros* antenna, thus enabling NASA's *Tiros III* shot to be made with only one day's delay).

It appears that all the praise for this feat was heaped upon one organization when, in truth, it should have been spread around a little more.

Radiation Incorporated and Dynatronics were equally responsible for the quick-fix of the San Nicolas antenna.

Radiation engineers removed the gear box from the Eglin antenna, the Navy airlifted the box, and Dynatonics made the installation.

The Radiation engineers who performed this task take a special pride in the fact that they played a significant part in the success of *Tiros III*.

Louis P. Clark, Jr.
Director of Public Relations
Radiation Incorporated
Melbourne, Fla.

You're spreading it.—Ed.

PERT Enthusiasm

To the Editor:

Congratulations M/R! By giving incisive coverage to the Navy's PERT scheduling system, you have uncovered for your subscribers the hottest O.R. product in management today. PERT has revolutionized the control and direction of projects whose size and complexity staggers the imagination.

For the record, let me comment upon the function of PERT or, for that matter, of any management method devised by trained operations research analysts. Churchman, Ackoff and Arnoff in their classic work *Introduction to Operations Research*, define O.R. as "The application of scientic methods, techniques and tools to problems involving the operations of a system so as to provide those in control of the system with optimum soluitions to the problems." The emphasis here is clearly on the directive function of managers. Thus when M/R, July 17, asks the question in connection with PERT, "Will computers replace managers?", I must answer that, on the contrary, PERT, which involves extensive use of high-speed digital computation, will make managers not only as necessary as ever but *more effective by orders of magnitude*.

The O.R. approach is breathing new life into the management profession by supplying managers with accurate, up-to-date, and clearly stated data on the basis of which meaningful decisions may be made. The prevailing misconception of O.R. and its function is widespread indeed. For instance, in M/R's July 24 COUNTDOWN we read that the Czar of Project *Apollo* is destined to "overshadow NASA top command." This cannot happen. If *Apollo* is completely PERTized, the man in charge will not "run the show," as you put it, but as a manager with intelligence and a sense of responsibility, be charged with making decisions *based on his cognizance of incoming, first-level PERT data*. Swift implementation of these decisions may be assumed. Thus the decisions will never be arbitrary in any sense. They will be the result of a rational interpretation of accurate inputs describing not only the present status of the Project but its predicted status in the future.

The most important managerial function here is converting PERT feedback into optimized corrective action with maximum response time.

A careful look at the history of Project *Polaris* should dispel speculation by top echelon at NASA that the *Apollo* Czar will "steal the show." Vice Admiral Raborn, far from "overshadowing" the U.S. Navy, has, in directing *Polaris*, demonstrated conclusively that scientific management techniques applied to the utilization of American technological genius can accomplish the impossible—ahead of schedule!

Incidentally, the U.S. Government Printing Office has published a document by the Navy Special Projects Office describing PERT fundamentals. For those interested, twenty-five cents will get "PERT—Summary Report Phase 1."

Lockheed Missile & Space Co.
Walter H. Trask
Sunnyvale, Calif.

Dyna-Soar's APS

To the Editor:

"DYNA-SOAR 'PICKS-OFF' *X-15* HARDWARE" (M/R, AUG. 7, P. 14) IMPLIES THAT THE ACCESSORY POWER SYSTEM TO BE USED IN THE *DYNA-SOAR* IS AN IMPROVED VERSION OF THE *X-15* HYDROGEN PEROXIDE UNIT. THIS IS INCORRECT. THE *X-15* APU IS A PRODUCT OF GENERAL ELECTRIC. THE *DYNA-SOAR* ACCESSORY POWER SYSTEM WILL BE DEVELOPED AND MANUFACTURED BY SUNDSTRAND AVIATION-DENVER, A DIVISION OF SUNDSTRAND CORP. THIS APS REPRESENTS A SIGNIFICANT ADVANCEMENT IN THE STATE OF THE ART IN APPLICATION OF HIGH-ENERGY TURBO MACHINERY.

R. Boyer, Jr.
Sundstrand Aviation
Denver

Reds Report 160 R&D Shots in '60

by Bernard Poirier

RUSSIA LAUNCHED MORE research rockets from surface ships in 1960 than from any individual land site. Of the total 160 launchings, 67 were from ships in the Pacific Ocean and five from a ship in the Black Sea.

Details released last winter covering the first six months of 1960 listed only one vessel as the source of all Pacific experiments. However, the latest report for the remainder of the year said 40 additional rockets were fired "from special ships in the Pacific Ocean."

Of the land sites, the most active was in the Arctic—Heiss Island (Franz Josef Land). Through June, launchings there totaled 31. A decreasing effort of 23 through December accounts for a year's total of 54—considerably less than the number fired at sea.

In the published reports on the Soviet research shots, the only mention of radar tracking is in connection with the Black Sea series. In typical fashion, the first word of any shots from mobile sea bases came only when the Russians themselves announced them to the Secretariat of the Committee on Space Research in The Hague, Netherlands.

Soviet launchings of research rockets for period of July 1 to Dec. 31, 1960, as reported to COSPAR

MONTH	PLACE OF LAUNCHING			
	HEISS ISLAND	EUROPEAN USSR	PACIFIC	TOTAL
JULY	0	2	9	11
AUGUST	1	10	10	21
SEPTEMBER	6	3	0	9
OCTOBER	6	5	0	11
NOVEMBER	6	1	9	16
DECEMBER	4	3	12	19
TOTAL	23	24	40	87

• **Limited data**—The new report differs from the earlier one in that it withholds coordinates of any launch site, names of vessels, actual dates and times of day the launches occurred.

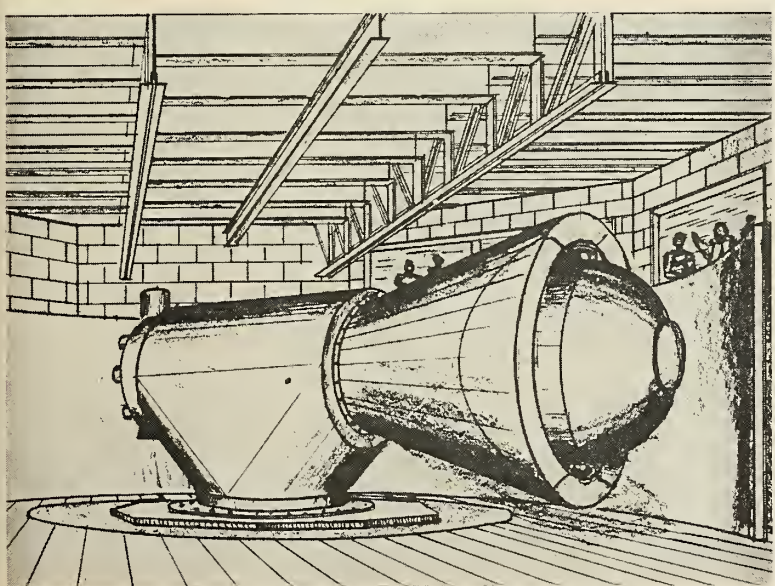
The earlier report had made it possible to extrapolate Russia's program of increasing the number of probes just prior to an important event—for example, the firing on a new "super missile" into a South Pacific impact area early in the year.

On another occasion, the tempo of launchings was stepped up until 3 A.M. on the day *Sputnik IV* was orbited. The new report has cut off this source of information, and the most significant information remaining is the number of launchings in a month when a major event took place.

Sputnik V, for instance, was orbited and recovered in August. The chart shows that August was the most active months in the last half of the year, with 21 admitted launchings. December, when Russia failed to retrieve an orbited capsule, saw the second largest number of probes—19.

As reported in MISSILES AND ROCKETS (Dec. 19, 1960, p. 29), the coordinates for the Arctic launching site are 80° 37′ N, 58° 03′ E. Two expedition vessels were identified as mobile, seagoing launch sites—the Voyeikov in the Pacific, the Shokalsky in the Black Sea.

What originally was identified as the "medium latitudes" of European U.S.S.R. is now nebulized to "mean latitudes". Activity in this area rose from 10 launches in the first half of 1960 to 24 from July through December. ⁂



Escape Trainer for Dyna-Soar Pilot

ACCELERATION FORCES likely to be encountered by crews of advanced vehicles such as the Dyna-Soar and B-70 will be duplicated for training purposes in a Dynamic Escape Simulator to be designed, developed and built by The Franklin Institute, of Philadelphia, under a $1.7-million contract from Aeronautical Systems Div. of the Air Force Systems Command. The Simulator, shown in an artists's conception, will apply pressures up to 20 g. It is slated to be operational by early 1963.

Boeing Presses Electronics

THE BOEING CO. has regrouped its Aero-Space Division and formed a new electronics design organization to "bring into sharper focus the Boeing Company's extensive activities in electronics."

The electronics packaging design section, under R. W. Lantz, is composed of design specialists in airborne and ground-based missile electronics. It will support design requirements for existing and proposed Boeing projects.

A new post of electronics manufacturing manager was assigned to R. H. Nelson, former manufacturing manager for Boeing's *Bomarc* program. His organization's responsibilities will cut across program lines to include all electronic and electrical manufacturing in the Aero-Space Div.

A Boeing spokesman said there are 21 separate electronics groups within the division, specializing in such areas as countermeasures, electronic environment, radar optical systems, infrared, communications, radio navigation, antenna development, semiconductor applications and electrical materials studies. He said the division has purposely kept its numerous electronic units small to "preserve flexibility and promote an effective work atmosphere."

JENSEN ENGINEERING, INC., has been formed in Palo Alto, Calif., to provide services and equipment in the field of satellite communication. Officers of the new organization are George M. Rouzee, President; John C. Keyes, Vice President.

DAYSTROM, INC. is transferring its Weston recorder controller and industrial gauge operations from Poughkeepsie, N.Y., to its Archbald, Pa., facilities. The shift is scheduled for completion by the end of September.

DYNATECH, INC. has been formed in Miami, Fla., to specialize in research and manufacture of advanced electronics devices. The firm's president, Dale Danielsen, said "we will concentrate heavily on the research and development of the relatively new RF modules."

SANDERS ASSOCIATES, INC. has opened an Advanced Communications Lab in Washington, D.C., to do R&D of sophisticated communications systems. Lawrence W. Sharpe has been named plant manager.

ATLANTIC RESEARCH CORP. has acquired through exchange of stock Flight Science Lab., Inc., Buffalo, N.Y. Flight Science will be operated as an Atlantic Research Corp. group. In addition to basic and applied research studies, FSL is engaged in the study and design of weapon systems.

MISSILE SYSTEMS CORP. has announced plans for construction of a $2-million computer center. MSC chairman, F. W. Bailey, said the new center continues the expansion program into the growing technical publishing and electronic data processing market.

B-I-F INDUSTRIES is now a division of The New York Air Brake Co. B-I-F is involved in automatic flow control, measurement, and weighing of gases, liquids and solids.

RYAN AERONAUTICAL CO. established a European office in Paris under the direction of retired French Air Force Lt. Col. Alain C. Jourdan. The company says the recent step-up in use of American military equipment in NATO countries has increased the market potential for electronic navigation sets and the Ryan *Firebee* target missiles.

BETHLEHEM CORP. acquired the assets of International Radiant Corp., New York City. IRC key personnel have joined Bethlehem's Environmental Engineering staff. The Division designs and manufactures environmental test equipment. Bethlehem Corp. recently changed its name from Bethlehem Foundry and Machine Company.

ELECTRO CUBE, INC., Pasadena, Calif., has been formed to specialize in design and manufacture of microminiature precision capacitors.

Financial Reports

COMPANY	PERIOD	INCOME		EARNINGS	
		1961	1960	1961	1960
Aero-Flow Dynamics, Inc.	6 Mo. June 30	$ 2,549,551	$ 2,653,393	$ −86,362	$ −74,143
Baurns, Inc.	6 Mo. June 30	6,921,888	5,332,584	445,489	341,410
Clevite Carp.	6 Mo. June 30	46,700,745	51,409,665	2,423,739	3,930,395
Dynalectran	6 Mo. June 30	17,245,034	16,531,797	201,968	−370,010
Electro-Instruments	Year, May 31	8,364,067	9,430,035	−381,752	706,708
Electranic Specialty Co.	6 Mo. June 30	12,728,223	5,068,008	477,118	12,529
Fairchild Stratas Carp.	6 Mo. June 30	39,742,000	45,549,000	1,639,000	−587,000
General Precisian Equipment Corp.	6 Mo. June 30	118,903,557	120,722,804	2,488,704	2,369,183
Hoffman Electranics	6 Mo. June 30	31,336,996	23,935,550	349,657	123,054
Lear, Inc.	6 Mo. June 30	48,322,717	45,613,074	2,121,182	2,011,098
Lackheed Aircraft Carp.	6 Mo. June 30	679,163,000	657,077,000	9,223,000	−55,409,000
Laral Electranics	3 Mo. June 30	9,606,000	9,084,000	350,000	310,000
Marquardt Carp.	28 Wks. July 14	24,690,485	36,318,093	356,461	599,597
McCarmick Selph	Year April 30	1,900,000	1,500,000	52,971	53,387
Narth American Aviatian	9 Mo. June 30	893,128,162	717,445,130	18,539,000	16,526,000
Texas Instruments	6 Mo. June 30 3 Mo. June 30	119,860,000 60,883,000	116,051,000 59,853,000	6,374,000 2,601,000	7,921,000 3,991,000
Thiokal Chemical Carp.	6 Mo. June 30	84,996,405	83,361,675	2,242,755	1,736,648
Taal Research and Engineering Carp.	9 Mo. April 30	10,597,167	2,610,596	445,515	164,207
United Electro-Dynamics	6 Mo. June 30	5,398,534	3,954,227	61,527	209,194
Varian Assaciates	39 Wks. July 1	42,296,488	34,392,995	2,351,813	2,180,255
Westinghause Electric Carp.	6 Mo. June 30	920,381,000	953,844,000	19,561,000	40,454,000
Zera Manufacturing Ca.	3 Mo. June 30	1,815,221	1,492,782	77,521	60,757

missiles and rockets
4th Annual

ground support equipment issue

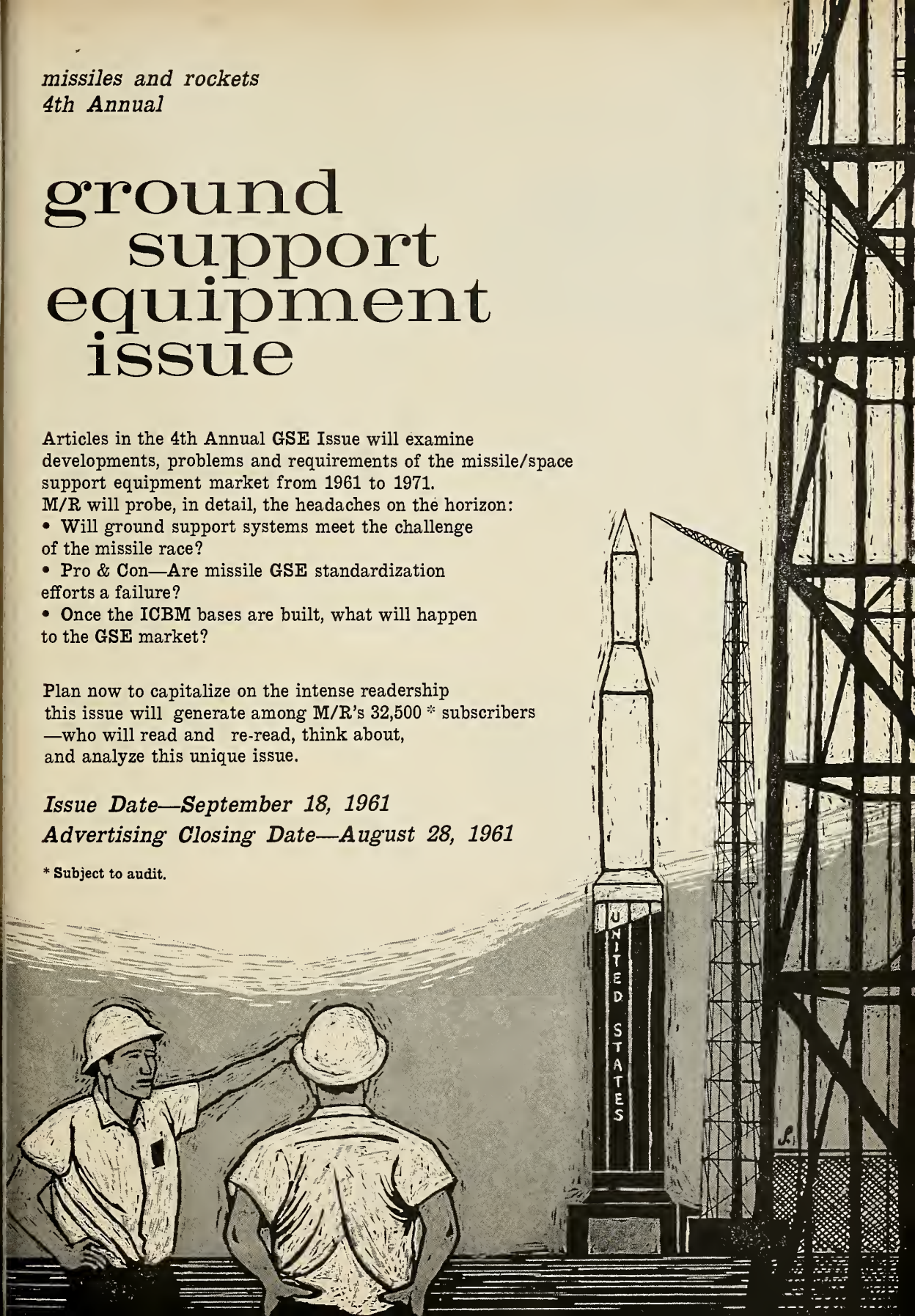
Articles in the 4th Annual **GSE** Issue will examine developments, problems and requirements of the missile/space support equipment market from 1961 to 1971.
M/R will probe, in detail, the headaches on the horizon:

- Will ground support systems meet the challenge of the missile race?
- Pro & Con—Are missile **GSE** standardization efforts a failure?
- Once the **ICBM** bases are built, what will happen to the **GSE** market?

Plan now to capitalize on the intense readership this issue will generate among M/R's 32,500 * subscribers —who will read and re-read, think about, and analyze this unique issue.

Issue Date—September 18, 1961
Advertising Closing Date—August 28, 1961

*** Subject to audit.**



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contracts

AIR FORCE

$8,000,000—**Bendix Systems Div.,** Ann Arbor, Mich., from Electronic Systems Div., Hanscom Field, Mass., for work on a rocket-borne communications system.

$7,078,060—**North American Aviation, Inc.,** Los Angeles, for design and development of guided missiles and trainer kits for use with F-100 aircraft.

$3,685,279—**Laboratory for Electronics, Inc.,** Boston, for components of the AN/APN-131 radar set and data.

$1,577,102—**Hughes Aircraft Co.,** for production of shipping and storage cases for missiles.

$1,250,000—**The Martin Co.,** Baltimore, for repair, modification, technical order compliance, test, preventive maintenance and reclamation of *TM76B* missile weapon system components and related equipment.

$1,133,000—**General Electric Co.,** Philadelphia, for research and development of *Samos II* program.

$1,014,548—**The Martin Co.,** Baltimore, for maintenance of *Matador* and *Mace* missile systems.

$1,100,000—**Astro-Science Corp.,** for follow-on for Dew Line mobile ground support systems and pod-handling systems for the B-58, plus spares.

$762,927—**General Electric Co.,** Defense Electronics Div., Utica, N.Y., for components of countermeasures receiving set, AN/ALR-18; spare components and parts, aerospace ground equipment, mobile training unit and data.

$629,612—Goodyear Aircraft Corp., Akron, Ohio, for services and supplies required for repair, calibration, test, overhaul and preventive maintenance of *Mace* map synthesis equipment.

$600,000—**Radiation, Incorporated,** Melbourne, Fla., for design of ground antenna system for *Dyna-Soar* glider program.

$395,209—**Goodyear Aircraft Corp.,** Akron, Ohio, for storage and distribution of *Mace* aerospace ground equipment, AN/DPQ-4 nose sections, XD coded spares and components, and XB coded spares to support the GAC-DM facility.

$300,000—**Systems Div., Daniel, Mann, Johnson, & Mendenhall,** Los Angeles, from Edwards AFB Flight Test Center, for preliminary design for a toxic-propellant rocket propulsion test system; feasibility studies and designs of future prototype and unique rocket test systems; and operations research study of design criteria for missile static-test facilities. (3 contracts).

$285,000—**General Precision, Inc., GPL Div.,** Pleasantville, N.Y., from Aeronautical Systems Div., Dayton, for research and development for a nuclear gyroscope which would use the nucleus of the atom as a reference.

$270,000—**Houston Fearless Corp.'s Westwood Division,** for design and manufacture of an electronically controlled random access photographic storage and retrieval system for Rome Air Development Center.

$175,000—**Gilliland Instrument Co., Inc.,** Oakland, Calif., from Missile Test Center, Cape Canaveral, for production of a device for "reading" films of missiles in flight.

The Marquardt Corp., Pomona, Calif., from Aeronautical Systems Division, for prototype radar simulator which will simulate radar scanning by means of a light optical scanning principle. No amount disclosed.

MISCELLANEOUS

$6,300,000—**Aerojet-General Corp.,** Azusa, Calif., from NASA and AEC, for preliminary work on an atomic engine. **Westinghouse Electric Corp.,** will be subcontractor for nuclear portions of the work.

Wiley Electronics Co., Phoenix, Ariz., from **Ford Motor Co.'s Aeronutronic Div.,** for production of altimeter for *Ranger* spacecraft lunar capsule. No amount disclosed.

NAVY

$7,500,000—**Electric Storage Battery Co.,** Philadelphia, for submarine batteries.

$1,178,955.—**United Electrodynamics, Inc.,** Los Angeles, from BuWeps, for transitorized airborne telemetry systems for converting obsolete jet fighters into target drones.

$1,158,000—**FMC,** San Jose, Calif., for a prototype of amphibious support vessel with retractable hydrofoils.

$1,040,782—**Mid-Indiana Mfg. Corp.,** Indianapolis, for *Zuni* rocket launcher.

Ryan Aeronautical Co., San Diego, from BuWeps, for logistic support of *Q-2C Firebee* jet drone operational program. No amount disclosed.

ARMY

$1,442,520—**Acme Missile & Construction Corp.,** Rockville Centre, N.Y., for construction of *Polaris* Class 9 facilities, Cape Canaveral Missile Test Annex.

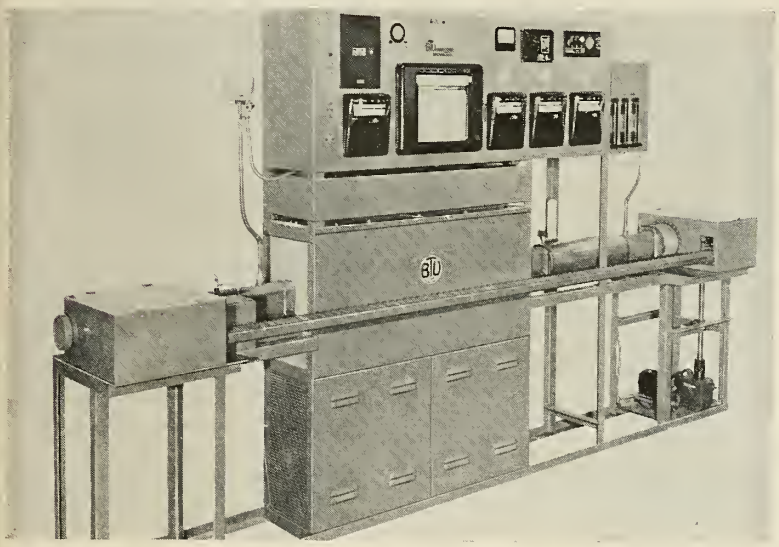
$328,433—**General Atronics Corp.,** Bala-Cynwyd, Pa., for design, development and testing of new communications system (Kathryn).

$325,000—**Radioplane, Div. of Northrop Corp.,** Van Nuys, Calif, for 2 sets test equipment for AN/USD-1 surveillance drone system.

$300,000—**Bendix Systems Division,** Ann Arbor, Mich., from Signal Supply Agency, Philadelphia, for modification of *Advent* communications satellite system.

$156,923—**Granger Associates,** Palo Alto, Calif., for ionospheric sounding equipment.

Temco Electronics and Missiles Co., subsidiary of Ling-Temco Electronics, Inc., Dallas, for manufacture of the afterbody of the atomic projectile for *Davy Crockett* weapon system. No amount disclosed.



Furnace Eliminates Manual Soldering

Fluxless soldering production methods which eliminate manual soldering and produce uniform results at lower cost are available with a horizontal Transheat soldering furnace developed by BTU Engineering Corp., Waltham, Mass.

Designated the TSH, the new furnace has provisions for single-station loading and unloading, unlike a belt-type furnace which requires operators at both ends. It has a continuous, horizontal, closed-loop chain drive with boats onto which parts, or preloaded fixtures are placed. The fixtures, holding component elements and solder preforms, move into the furnace, where soldering is accomplished under carefully controlled temperature and atmosphere, and return to the same front station at which they were originally loaded. The length of the conveyor can be made to accommodate any desired number of operator stations.

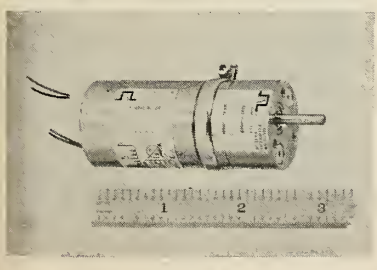
Temperature profiles of the product can be controlled to ±1°C. The furnace is rated to 600°C. Closely controlled hydrogen atmosphere within the furnace eliminates the need for handling flux, and produces a clean, oxide free bond with good wetting characteristics.

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Step Servo Drive

A 1/10 revolution (36°) step-servo drive for digital system application is being introduced by Automation Development. Since the output shaft rotates bi-directionally 36° or 0.1 revolutions per each input pulse, this drive can be directly coupled to digit wheels and counters and other digital control equipment. The drive utilizes precision ball bearings and consists of an ADC standard step-servo motor in combination with an integrally mounted in-line gear head. This drive, when operated in conjunction with ADC's standard step-servo controllers and pulse sources can achieve instantaneous reversal at speeds up to 200 pulses per second.

Circle No. 226 on Subscriber Service Card



Temperature Chamber

Delta Design, Inc. has added a large volume-low gradient model to their line of temperature chambers. The Model 1060B chamber has temperature profile characteristics suitable for Mil-Spec testing of large assemblies where temperature variation throughout the specimen, including gradient, control variations, and drift is not to exceed ±1°C. The large test volume, approximately six cubic feet, permits evaluation of fairly large specimens.

Circle No. 227 on Subscriber Service Card

Electronic Level Check

An Electronic Level, a new type of precision instrument in which the standard bubble is replaced by a pendulum and a pair of variable-inductance transducers which provide an electrical displacement signal, is available from Engis Equipment Co. This signal is amplified to feed a center-zero meter. The Talyvel is battery-operated. The transistorized amplifier and meter is scaled in angular measure as well as linear, to indicate precisely the amount of tilt of the Talyvel unit. The pointer comes to rest in about one second.

Circle No. 228 on Subscriber Service Card

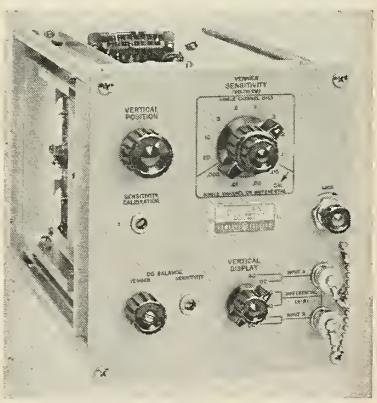
Noiseless Transducers

A variable piezoelectric transducer whose mount eliminates more than 85% of the noise produced by more conventional transducers has been made available for military and laboratory environmental testing applications by the Mirax Chemical Products Corp. The Variducer can be used to measure shock velocity, blast pressure, compression and expansion wave durations, force, and other parameters. Designed to meet any pressure in the transducer field, the unit will also withstand temperatures up to 300°C.

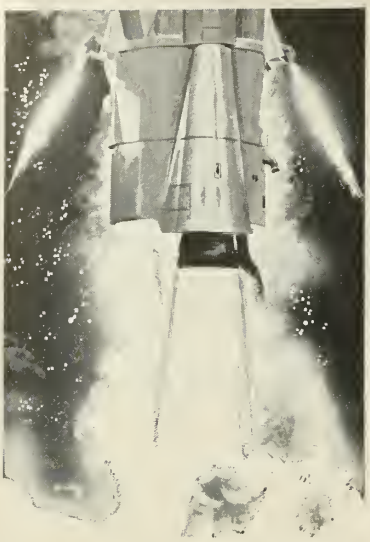
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High Gain Amplifier

A high gain amplifier which combines high common mode rejection with 5 mv/cm sensitivity and low drift



is available from Hewlett-Packard Co. The amplifier, Model 162D, is a plug-in unit designed for the Hewlett-Packard Model 160B and 170A oscilloscopes. The Model 162D has 12 calibrated ranges 5 mv/cm to 20 volts/cm, with a vernier providing continuous adjustment between ranges and extending minimum sensitivity to at least 50 volts/cm. At maximum sensitivity,



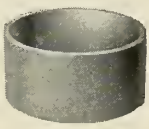
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...rewriting the book on thermal protection

Reinforced plastics make it possible to design parts that will withstand 10,000°F. At heats where other materials fail suddenly, reinforced plastics ablate uniformly.

R/M asbestos-phenolic parts are used on virtually every U.S. missile. They exhibit a highly desirable combination of properties such as low thermal conductivity and diffusivity, low rate of ablation, high strength-to-weight ratio, excellent shock resistance and structural integrity.

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Tape wound rocket motor tube liner of R/M Style 41RPD Pyrotex.®

RAYBESTOS-MANHATTAN, INC.
Reinforced Plastics Department, Manheim, Pa.

SPECIALISTS IN ASBESTOS, RUBBER, ENGINEERED PLASTICS, SINTERED METAL

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the 162D/170A combination has a rise time of less than 10 nanoseconds; the 162D/160B combination has a rise time of less than 29 nanoseconds.

Circle No. 230 on Subscriber Service Card

Giant Vacuum Pump

The addition of a 32-in.-diameter oil-diffusion vacuum pump to its PMC pump line has been announced by Consolidated Vacuum Corp. This pump, designated Type PMC-50000, is the largest of its kind in the high-vacuum field and was developed specifically for the fast, clear evacuation of the very large space chambers used in space simulation studies. It consistently provides a plateau speed, hitherto unknown to any high vacuum pump, of 52,000 liters per second throughout the 3 x 10^{-5} to 4 x 10^{-4} mm Hg pressure range. It has a baffled ultimate pressure of 2 x 10^{-9} mm Hg and a very low backstreaming rate of only 0.194 mg/cm²/hr.

Circle No. 231 on Subscriber Service Card

Serial Type Memory Device

Utilizing a quartz delay line, a device storing 65 bits of information at a 10 megacycle counting rate with an access time of less than 4 micro-seconds is available from Anderson Laboratories Inc. It may replace other components

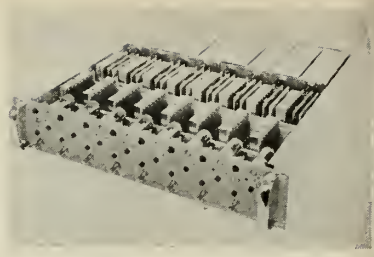


now used in digital computers which are substantially larger in size and cost. In this application this is the first time that a high speed, short delay package has been achieved. This unit operates at a counting speed over ten times greater than was heretofore practical with acoustic delay lines.

Circle No. 232 on Subscriber Service Card

Signal Conditioner

Astra Technical Instrument Corp. has available a line of strain-gage signal conditioning equipment of which the SSC-1 is the initial production model. This eight-channel, rack-mounted unit offers these advantages: any configuration of bridge circuitry (1-, 2-, 3-, or 4-active arms); up to four calibration



points; single and double shunt; plus or minus and plus and minus calibration, all merely by changing plug-in cards without rewiring. Each channel consists of an isolated, highly regulated power supply; precision calibration circuitry; connections that provide missing segments of a full bridge; and circuitry for remote or local calibration and control.

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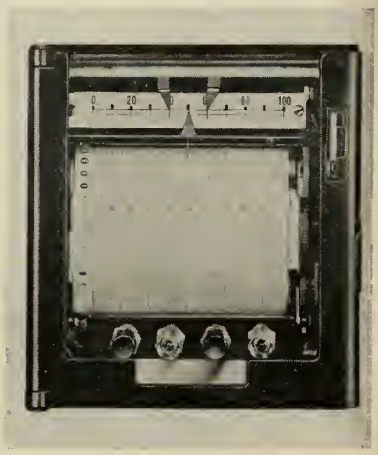
Welding Power Source

Simplified controls for both gas-shielded arc and submerged arc welding is a feature of an RCP Industrial d-c arc welder, for semiautomatic and automatic operation, from Westinghouse Electronics Corp. Now available, this selenium-rectifier, 500-600 amp power source is designed to meet the demands for the majority of arc-welding processes in the metal-working industry. It provides the relatively flat voltampere characteristics required for maximum arc stability for both automatic and semiautomatic welding. This insures instant arc starting and recovery, reduced burn back and stubbing.

Circle No. 234 on Subscriber Service Card

4-inch Telemeter Receiver

A line of 4-inch chart width telemeter receivers (Series 670) is available from the Bristol Co. Designed to fit any Metameter telemetering system, the instruments are offered with one or two pens. Each pen is available with one or



two retransmitting slidewires, and a maximum of four individually adjustable alarm contacts. Each alarm contact has an individual scale. Two of the maximum eight alarm contacts can be set from the front.

Circle No. 235 on Subscriber Service Card

Resistance Transducer

Winsco Instruments & Controls Co. introduced Model 2508, a high temperature, surface, resistance-temperature transducer. Using a platinum element, this ultra-thin rectangular transducer provides continuous operation at temperatures as high as 2000°F. Winsco's special high temperature cement is the preferred method for installing the Model 2508 on a surface where temperature is to be measured. This cement cures by air-drying at room temperature and maintains its bond strength beyond 2000°F. Installation by welding is also possible.

Circle No. 236 on Subscriber Service Card

Magnetic-Tape Certifier

An automatic system for detecting defects in magnetic tapes has been developed by Cybetronics, Inc. This system, the Model C Magnetic Tape Certifier, can be used with any tape transport at its normal speed and packing density. All channels are inspected simultaneously in a simple, push-button-controlled operation. After the "start" button is pushed, the tape moves until a drop-out occurs. The tape can then be checked within the inspection area provided in the transport and can be advanced or rejected, depending on the nature of the defect that caused the drop-out.



Circle No. 237 on Subscriber Service Card

3000 PSI Lo-Torq Valve

A 3000 psi series 8600 Lo-torq Selector Valve in the price range of spool valves is the latest offering of the Republic Manufacturing Co. This line, while in the spool valve price range, offers many advantages over the spool type. There is no internal leakage in indexed positions, and little during port selection. The pressure balanced valving disk makes turning easy. Maximum working pressures are 3000 psi for oil service, and 2000 psi for lubricated air service.

Circle No. 238 on Subscriber Service Card

D-C Corona Tester

A new corona test set with 20 kv corona-free d-c high voltage supply, corona pickup filter network and corona detector is available from Associated Research, Inc. The Model 5435 D-C Corona Test Set detects corona discharge and displays the voltage pattern on a built-in oscilloscope having special characteristics. The vacuum bell-jar and table mounted at the top of the cabinet are evacuated by an internally mounted vacuum pump.

Circle No. 239 on Subscriber Service Card

Microwave Phase Shifter

E & M Laboratories has developed a phase shifter which provides a considerable amount of phase shift over an extended bandwidth. This unit covers the 8.5 to 10.2 kmc/s region, providing in excess of 600° phase shift above 9.8 kmc/s. The drive requirement for this unit is 800 ma of d-c current, which can be modified for other current levels and for a-c modulation. The length of 7¾ inches, bandwidth, center frequency, and phase shift can be varied.

Circle No. 240 on Subscriber Service Card



MODELS 2410 and 2411

RUSKA DIFFERENTIAL PRESSURE INDICATOR



Sensitivity: .0002 psi/scale division. Maximum operating pressure: 15,000 psi. Maximum overpressure: 15,000 psi.

Ruska engineers have designed a new differential pressure indicator that is highly sensitive to a differential pressure and is also capable of withstanding high overpressures.

The electronic circuitry incorporates conservatively operated components and semi-conductors for small size and high reliability.

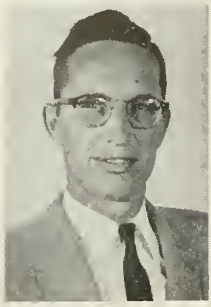
The unit is simple in design, rugged, and easy to adjust and operate. A most convenient feature of the unit is the meter readout which is a function of the differential pressure. Full scale on the meter readout denotes a differential of 0.05 psi (Model 2410) or 0.005 psi (Model 2411), each scale division denoting approximately 0.002 psi (Model 2410) or 0.0002 psi (Model 2411).

For complete information, call or write:

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names in the news


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BURNS


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KIRSCH


TOBIN

Leo A. Carter: Former vice president-general manager, Douglas Aircraft Co., Santa Monica, and 30-year Douglas veteran, named assistant for management evaluation to vice president and space systems divisions general manager, Lockheed Missiles and Space Co., Sunnyvale, Calif.

Fred A. Payne, Jr.: Former manager of advanced systems planning, North American Aviation, Inc., appointed assistant director of defense research and engineering for strategic weapons. Payne succeeds **Dr. Marvin Stern,** who was named DOD's deputy director of weapons systems in June.

Theodore J. Nussdorfer: Named manager of aerospace systems research, Geophysics Corporation of America, Bedford, Mass. Nussdorfer formerly was a group leader in evaluation of ballistic missile defense systems for Arthur D. Little, Inc.

Roswell P. Barnes: Appointed head of Melpar's Applied Science Division Physics Laboratory, Watertown, Mass.

Dan W. Burns: Appointed vice president in charge of defense activities for The Siegler Corp., Los Angeles. **Walter J. Kruel** succeeds Burns as president of Siegler's Hufford Division, El Segundo.

Dr. Arnold T. Nordsieck: University of Illinois physics professor since 1947, appointed to head Technical Specialties Dept., General Motors Defense Systems Divisions, Santa Barbara, Calif.

Francis J. Dunleavy: Named general manager, Communications and Controls Division, Radio Corporation of America. Dunleavy formerly was general manager, industrial controls.

Jack S. Parker: Appointed vice president and group executive in charge of Electronic and Flight Systems group, General Electric Co.; **Robert E. Pfenning** named comptroller; **Virgil B. Day** named vice president in charge of relations services.

Dr. Artur Mager: Appointed assistant director of spacecraft sciences, Aerospace Corp., Los Angeles. Before joining Aerospace Corp., Dr. Mager was director of sciences, National Engineering and Science Co., Pasadena.

Fredric M. Cooper: Former director of engineering, appointed vice president and general manager of Amcel Propulsion, Inc., Asheville, N. C.

Ivan E. Walenta: Appointed chief of space instrument systems section, Jet Propulsion Laboratory, Calif. Institute of Technology, Pasadena. **Herbert G. Trostle** promoted to assistant section chief of research analysis. Both sections are in the Space Sciences Division.

Richard K. Mosher: Promoted to vice president in charge of Systems Division, LFE Electronics, a major operating group of Laboratory for Electronics, Inc., Boston.

William D. McBride: Appointed director of information services, The Martin Co.'s Denver division, succeeding **Don P. Herron,** who joins the corporate staff as director of information programs at Martin's headquarters, Friendship International Airport, Md.

Lawrence H. Dworetzky: Appointed associate director, Advanced Systems Planning, General Precision, Inc., Tarrytown, N.Y. Dworetzky formerly was head of advanced systems development of AC Spark Plug's Wakefield research laboratory.

Lee N. Mortenson: Named manager, research and analysis department, Wyle Laboratories, El Segundo. Mortenson will continue as program manager, Air Force Ballistic Systems Division Program at Wyle.

J. P. Field: Promoted to director of programs, Bendix Corp.'s Mishawaka Division in Indiana. Reporting to Field will be **E. F. Lapham** as *Typhon* program manager, **T. S. Torian** as *Talos* program manager. **J. A. Reed** appointed contracts manager, with **D. A. Tuttle** as estimating manager.

Alfred C. Evans: Named director of research and development, Weston Instruments Division, Daystrom, Inc., Newark, N.J. **George V. Gerber** appointed chief components engineer in the Military Electronics Division in Archbald, Pa.

Joseph E. O'Hara, Jr.: Appointed vice president, Datatrol Corp., Silver Spring, Md. Previously O'Hara was a systems analyst for Department of Defense.

Donald D. Kirsch: Appointed manager of aerospace electronics marketing department, Waltham Laboratories of Sylvania Electronic Systems, a division of Sylvania Electric Products, Inc. **Arne Schleimann-Jensen** named manager of product engineering for Microwave Device Operations plant of Sylvania, Mountain View, Calif.

Dr. Edward G. Witting: Appointed manager of research and new products, Cannon Electric Co., Los Angeles. Dr. Witting leaves the post of Deputy Assistant Secretary of Army (R&D) to assume the new research position.

Dr. Wernher von Braun: Director of the National Aeronautics and Space Administration's George C. Marshall Space Flight Center, Huntsville, Ala., named Honorary Space Chairman of the 1962 Seattle World's Fair.

Dr. John N. Dempsey: Named director of Minneapolis-Honeywell's Research Center and associate director of the company's over-all research activities. Dr. Dempsey succeeds **Dr. Van W. Bearinger,** appointed general manager of Honeywell's Semiconductor Division.

William H. Enders: Appointed manager, Advanced System Projects, RCA's Aerospace Communications and Controls Div., Defense Electronic Products, Burlington, Mass. Enders formerly was administrator, market research and analysis, for the same division.

LaVerne J. Tobin: Named vice president-sales and a member of the board of directors, American Orbitronics Corp., Washington, D.C.

Eugene Fioramonti: Elected vice president, Powertron Pacific Corp., Los Angeles, a subsidiary of Powertron Ultrasonics Corp.

Dr. R. E. Henning: Promoted from engineering manager to chief engineer, Sperry Microwave Electronics Co., Clearwater, Fla.

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—when and where—

AUGUST

National Academy of Sciences 10th Pacific Science Congress, University of Hawaii, Honolulu, Aug. 21-Sept. 8.

American Rocket Society Fourth Biennial Gas Dynamics Symposium, cosponsored with Northwestern University Technological Institute, Evanston, Ill., Aug. 23-25.

American Institute of Electrical Engineers, Pacific General Meeting, Salt Lake City, Aug. 23-25.

AFOSR Sixth International Conference on Coordination Chemistry, sponsored with American Chemical Society, Wayne State University, Detroit, Aug. 27-Sept. 1.

American Society of Mechanical Engineers 1961 West Coast Conference of Applied Mechanics, University of Washington, Seattle, Aug. 28-30.

ASME and AIChE International Heat Transfer Conference, New Developments in Theory and Practice, University of Colorado, Boulder, Aug. 28-Sept. 1.

Third International Symposium on Rockets and Astronautics, Japanese Rocket Society, Tokyo, Aug. 28-Sept. 1.

Second Annual Bionics Symposium, sponsored by General Electric Co. and Cornell University, GE Advanced Electronics Center, Ithaca, N.Y., Aug. 30-Sept. 1.

SEPTEMBER

Army Aviation Association of America Annual Meeting, Sheraton-Park Hotel, Washington, D. C., Sept. 3-5.

Farnborough Exhibition, England, Sept. 4-10.

Eighth Anglo-American Aeronautical Conference, Royal Aeronautical Society and Institute of the Aerospace Sciences, London, Sept. 4-14.

National Conference Institute of Engineering Inspection and Society of Non-Destructive Examination, Oxford, England, Sept. 5-8.

Joint Nuclear Instrumentation Symposium, sponsored by IRE's professional groups on Nuclear Science and Instrumentation, AIEE, ISA, and others, North Carolina State College, Raleigh, Sept. 6-8.

National Symposium on Space Electronics and Telemetry, IRE, University of New Mexico, Albuquerque, Sept. 6-8.

National Conference, Association for Computing Machinery, Statler-Hilton Hotel, Los Angeles, Sept. 6-8.

1961 New Product Exhibit and Conference, Los Angeles Chamber of Commerce, Ambassador Hotel, Sept. 7-8.

1961 Fall Meeting of The Combustion Institute, Western States Section, University of California, Berkeley, Sept. 7-8.

National Aeronautic Association 1961 National Convention, Westbury, L. I., N. Y., Sept. 10-13.

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Where the Money Ain't

RESEARCH AND ENGINEERING funds took the largest blow when Congress cut $112 million from the National Aeronautics and Space Administration budget. Some $73 million in R&E money was axed.

Technically, NASA now is in the process of deciding which programs to cut back as a result. In fact, the situation is not as serious as it might appear. NASA is likely to keep its programs going and, as it did last year in a similar situation, ask Congress in January for a supplemental appropriation to make up the deficit.

Just what the benefit of this financial hocus-pocus might be escapes us. But we can point out one of the disadvantages. Once again, it is made evident that research is a political football, the fiscal whipping boy. Once again, all those engaged in it are reminded that they are second-class citizens.

This is just at the time when the mammoth lunar exploration program is being cranked up. Research is going to be the guts of that program. If the industry and the nation are to obtain maximum benefits from the multi-billion-dollar lunar project, serious consideration must be given to the type and direction of the research involved.

The lunar program can provide the nation with a giant step forward in the technology which is this country's lifeblood. We are talking not merely about space technology but about the complete spectrum of this nation's scientific and industrial technology. Fallout from the lunar program could be exactly the jolt needed to push the U.S. ahead on many frontiers. Or the program could be just so much money poured down a bottomless lunar crater. The direction of the research effort will do much to determine which.

One of the industry's most able spokesmen, Daniel E. Noble, executive vice president of Motorola, put the problem extremely well in a recent issue of a company engineering bulletin. He writes:

"The emphasis of selected areas of research is not only the key to increased speed for all space exploration, but it is also a necessity for the support of our growth economy. The proposed spending of forty billion dollars to reach the moon can be a disastrous and unrealistic drain upon our economy, or it can be a constructive, progressive effort which will not only win for us the position of overwhelming leadership in the weapons race, but will also provide us with an increased spread of employment and a potential for a very substantial increase in the gross national product.

"If the forty billion dollars is spent primarily in an attempt, by brute force methods, to extend the space exploration capability of our comparatively primitive skyrockets, we will be faced with a disastrous waste of money. If we recognize that real speed is not achieved by brute force methods; if we recognize that the solution to a more sophisticated space flight capability lies in the laboratories; if we recognize the significance and the promise of the trend in applied science away from the macroscopic and toward the microscopic approach to materials and to solid state electronics, and if we balance a reasonable program of space flight testing with generous, vigorous, and selective pure and applied research programs which are based upon the identification and backing of men with ideas, we will not only end up with an overwhelming superiority in the field of space exploration, but we will open up a new source of essential custom-made materials and scientific information which will pace the continuing expansion of our technological culture and insure the continuing health of our economy.

"We know that the continuing increase in our gross national product is essential to our economic health and 'every schoolboy knows' that this expansion capability is tied to the availability of new scientific information which must come from effective pure research and applied research. I repeat that the spending of forty billion dollars for a skyrocket to the moon can be disastrous or it can be the most constructive, important and successful program ever undertaken as a national effort. We have a choice."

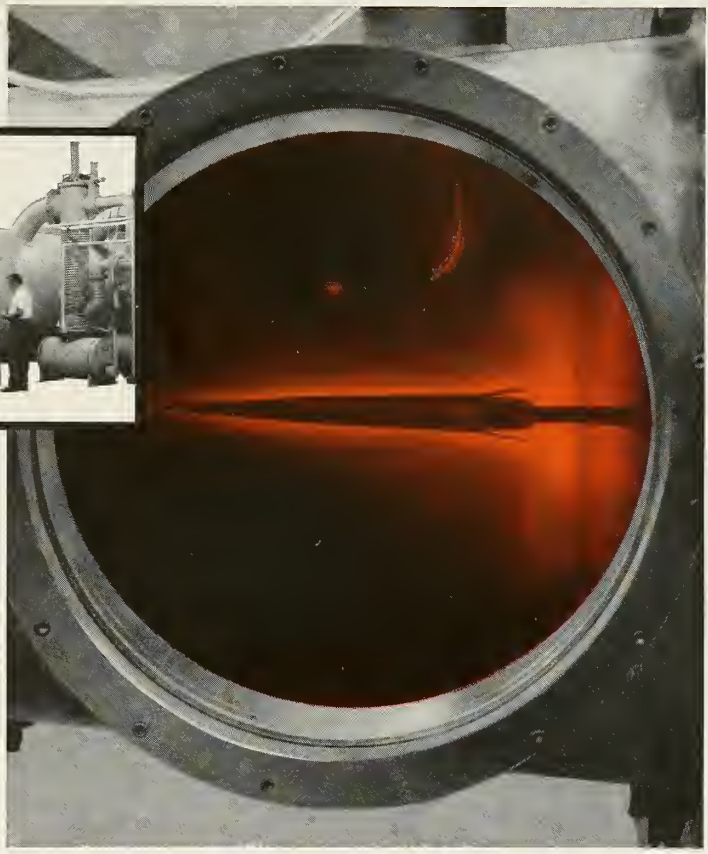
THESE ARE SERIOUS PROBLEMS which NASA must face in determining the direction of the lunar program. Mr. Noble's point that success will depend upon selected emphasis of potentially rewarding areas of research is an important one. Too much time and money can be wasted in trying to do everything in the hope that something will turn out well. The program must have forceful direction into the promising areas. This is not to say that every effort will succeed. There will be failures. But the percentage of success will be considerably higher.

And who must decide which are the most promising areas of research? A group of second-class citizens known as researchers. With the tremendous vote of confidence just given them by Congress on behalf of the nation, we know they are champing at the bit to tackle this great new challenge. They'll get their money in due course, naturally, but it is just as well to remind them, before their new assignment gets under way, of their true standing.

As Mr. Noble points out, pure research is practiced almost exclusively by fanatics who have never learned that where the glamor isn't, the money ain't.

William J. Coughlin





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Years before McDonnell space vehicles reach the testing centers at Canaveral, designs are subjected to the severe environment existing at the edge of space. At McDonnell's Hypervelocity Impulse Tunnel in St. Louis the combined electrical impulse power of the Grand Coulee and Hoover Dams breaks loose into the confines of a cannon-like funnel and subjects space vehicle models to simulated altitudes up to 60 miles, 14,000° temperatures and speeds up to Mach 27.

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The system introduces new Bell BRIG gyros. Its accelerometers and digital velocity meters are already operational in missile and space guidance systems.

Hipernas — and many other systems such as the Air Force GSN-5 and the Navy's SPN-10 All-Weather Automatic Landing Systems — typify Bell's capabilities in the broad field of electronics. This diversity of activities offers an interesting personal future to qualified engineers and scientists.

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missiles and rockets

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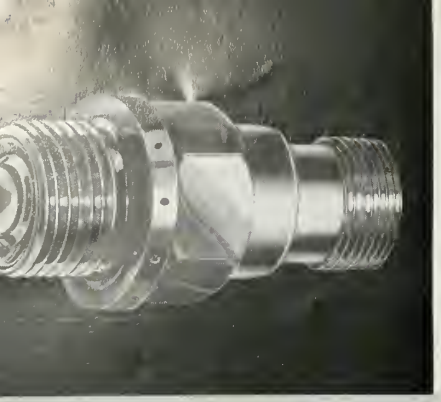


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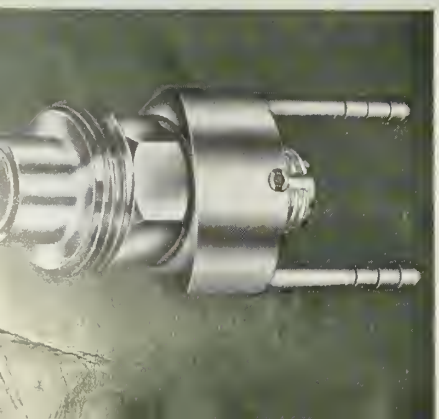
Exceedingly high frequency response characteristics (flat within ± 1 db from DC to 20,000 cps) result from the small mass and minute deflection of the assembly consisting of pressure sensitive diaphragm and strain tube with bonded strain gages. Models covering entire pressure range—0 to 60,000 psi—are virtually unaffected by extreme vibration or acceleration.

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Unique Norwood design offers repeatability better than 0.1%, linearity is ± 0.5% of full scale. Transducers are available in a variety of two and four arm bridge designs, including models with provision for external shunt calibration. Bonded strain gage design means low maintenance and high reliability.

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Models are available uncooled or for either air or water cooling. With air cooling gas temperatures as high as 2000°F can be applied safely. Water cooled models can measure gas pressures at temperatures to 5000°F, liquids to 1000°F.



Complete Norwood line is described in Bulletin 278. Write American-Standard Controls Division, 5900 Trumbull Avenue, Detroit 8, Michigan today for your copy.

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Microminiature Coaxial Connectors

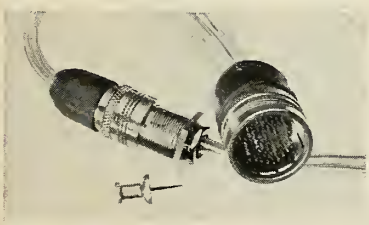


Microdot's microminiature connectors —including the world's smallest 50-ohm coax connectors—are available in over one million combinations. Plugs are available in straight or angle screw types and slide-on versions. Receptacles include printed circuit and bulkhead feed-thru types. Only highest quality materials are used. Conductors are of silver-plated copperweld or cadmium bronze, center contacts are of gold-plated coin silver. Housings are silver-plated brass to assure minimum electrolysis with aluminum panels. "Teflon," "Kel-F," polyethylene, and neoprene are used as dielectrics, jackets, bend relief caps, and pin protectors.

Microdot Inc., 220 Pasadena Avenue, South Pasadena, California

Circle No. 2 on Subscriber Service Card

Microminiature Multi-pin Connectors

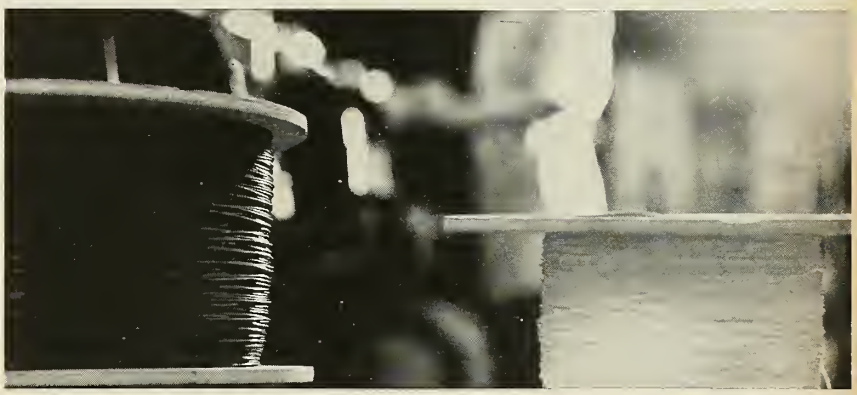


Only one-quarter the size of current "miniature" types, Microdot Multi-pins are available in three shell sizes to contain up to 61 power or 19 coaxial contacts in a 1¼" shell. Interchangeability of parts is featured with inserts available in a variety of straight power, straight coaxial, and combination power-coaxial contacts. Power contacts are interchangeable without changing inserts, allowing hermaphroditic contact arrangements to be set up. Microdot Multi-pins are available completely assembled with Microdot cable, or in unassembled kit form.

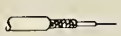
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MICROMINIATURE COAXIAL CABLE



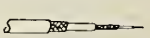
Microdot's Cable Facilities specialize in precise metallic braiding of microminiature coaxial cables. In a new, ultra-modern plant, special advanced techniques of cylindrical weaving are combined with the utilization of highest quality materials and rigid quality control methods, to produce a wide range of miniaturized RF frequency cables... cables designed and produced to yield the same matched impedance as required for larger cables.



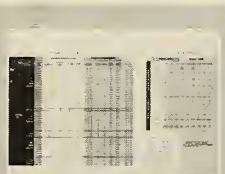
"Mini-Noise" cable, a result of Microdot research, is specially processed to minimize self-generated noise—prevents noise interference with low strength signals. These cables also offer high performance in extreme temperature ranges.



Twinax cable produced by Microdot is a shielded, twisted pair of conductors utilizing prime dielectrics for low loss, featuring controlled capacitance and impedance. Shield is added after insulation and conductors are arranged in a balanced to ground configuration.



Triax cable by Microdot offers rf leakage below the level experienced with Double Shielded Coax. Three active conductors permit feedback to cancel a known noise source. Capacitance cancelling hook-ups are possible for cathode followers.



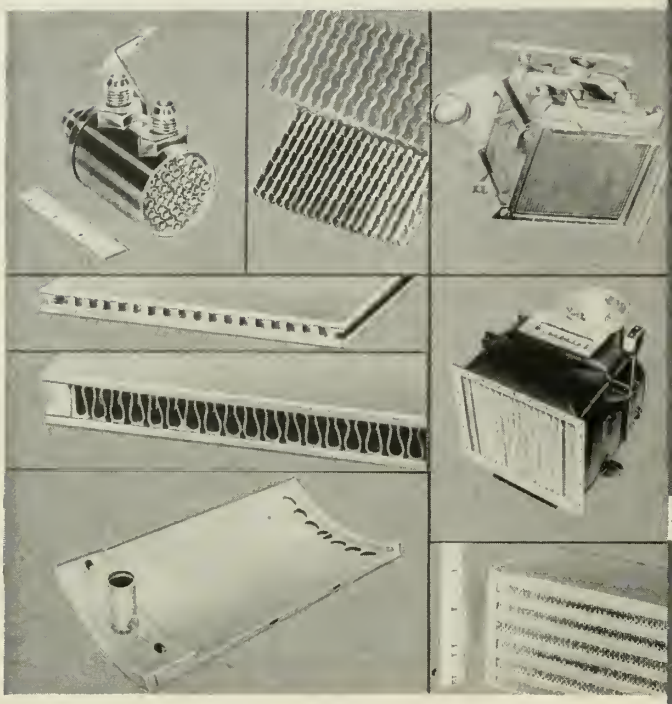
Use reader service card in this publication, or write today for 4-page folder of performance charts, design characteristics, and specifications on the following cables: Coax 50, 70, 75, 93, 95 ohm. Twinax 125 and 160 ohm. Triax 50 and 93 ohm.

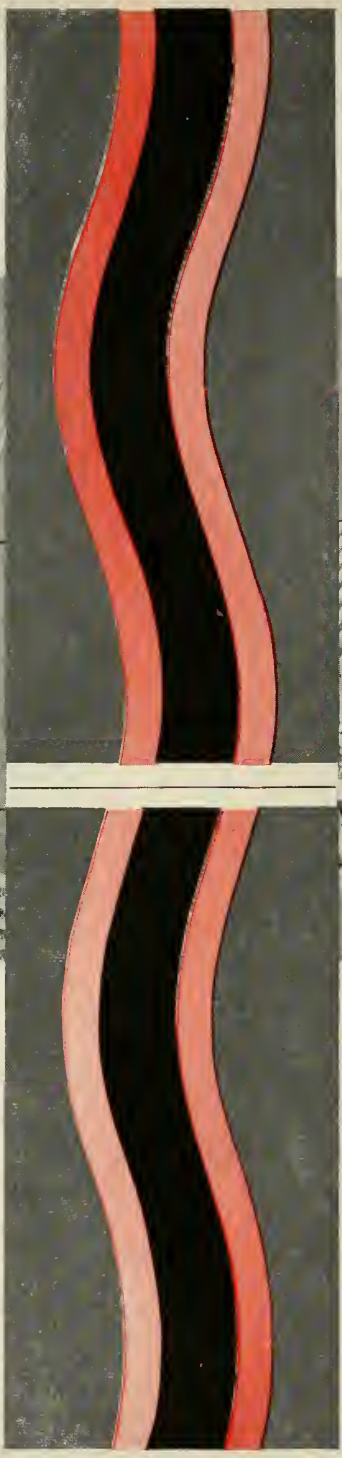
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THE MISSILE / SPACE WEEKLY

missiles and rockets

Volume 9, Number 9 August 28, 1961

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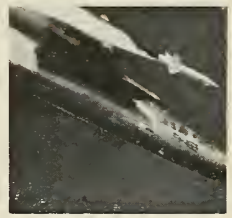
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THE COVER

Martin Bullpup air-to-surface missile is shown in newly released Defense Department photo an instant after launch from Air Force Republic F-105 tactical fighter.

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†U.S. Reg. Pdg.

36,322 copies this issue



letters

Senator's Rebuttal

To the Editor:

After reading your Aug. 7 editorial ("America Still Wants to Know"), which you so kindly sent me, I am rather confused as to just what is your editorial mission. Are you proposing to further the interest of missiles and rockets, or are you proposing to defend the inaccuracies of the *New York Times?*

First of all, let me agree with you in that I didn't think the (television) program you referred to was startling, nor did I think we developed the material that could have been developed—but this is no place to discuss the additives to that particular program.

The bulk of your editorial concerns a story in the *Times* by Jack Raymond, which I still maintain was completely inaccurate. If you will carefully read the entire story by Mr. Raymond, you will note that he flatly credited (Gen.) LeMay with plans to appeal for the B-70, which up to that time LeMay had never asserted. He further made the statement that the Air Force "is preparing a vigorous appeal to Congress," which the Air Force had never indicated that it would.

Then, if you would go further into the story, you find the *Times* credited completely to the Air Force a statement released by the Pentagon on the Moscow Air Show. The Air Force up to that time had no comments concerning the July 9th Air Show. As a matter of fact, General LeMay's answers were practically identical to those of General Tommy White's in prior Congressional testimony and were not based upon the Moscow Air Show.

As to this being a "heated denunciation of the *Times,*" I can't understand why one or two sentences out of hundreds during the course of an interrogation constitutes a "heated" discussion. I had made the denunciation on the Floor of the Senate two days before, and no one seemed to take any cognizance of it, which is normal with the liberal press of this section, but for you to spend an entire editorial on a case of irresponsible reporting, frankly, is beyond me.

The *New York Times* seems to be a little bit like some of the Scripture, "He dare not tread upon it." Inasmuch as you have asked for my rebuttal, I would say that if the title of your publication is MISSILES AND ROCKETS, I would stick to the subject. Don't spend your time defending inaccurate reporting by a publication that, as far as I know, is not related to yours, unless perchance it owns you.

Barry Goldwater
United States Senate

On 'Non-profits'

To the Editor:

I read Mr. Gene C. Burns' letter on nonprofit corporations (M/R, Aug. 7, p. 6) with great interest. Certainly, I don't pretend to speak for kindred organizations, but there are a few things that ought to be clarified from the point of view of The MITRE Corporation.

Mr. Burns accused MISSILES AND ROCKETS editors of supporting editorially the nonprofit corporations which provide technical advice to the military, because of space advertising placed with the periodical. Heaven help M/R if the dollars it receives from MITRE for technical recruitment "ads" are of major financial significance. Actually, trade publications derive the great majority of their advertising revenue from conventional profit-making and stock-issuing firms.

It is quite true that most of the "nonprofits" carry on public information activity. One of the most serious problems facing the world today is a basic limitation in the ability to communicate effectively. Narrow this problem to the United States and we find there is an acute communication problem in government and industry as a whole. Although no all-encompassing answers have been found, one solid step is a workable communications program for news media.

In truth, a non-stock, not-for-profit company is a much misunderstood business entity. Manufacturers invariably regard such firms with vague suspicion. Even arms of the government—and bear in mind The MITRE Corporation is chartered only to serve the government—have questions and doubts. They must learn that we do not compete with manufacturers, or even "in-government" organizations. Rather, we seek at all times to cooperate with them as an integral part of the government-industry team that, in MITRE's case, is facing up to the stern technical demands of electronic command and control work.

Occasionally, public information activity, particularly recruitment advertising, draws job inquiries from people, who for one or more reasons, do not qualify for posts with the involved organizations. When this happens, I submit it is regrettable, but hardly fraudulent.

As to disguising recruitment publicity effort in a "salary survey" budget, MITRE most assuredly does not. In fact, the firm has never conducted a formal salary survey. Should a survey be required, however, it would be handled openly and with no hidden purposes. Since MITRE does participate in certain national salary surveys, as a client, we seem to be in a position to observe any untoward actions on the part of other "nonprofits." There has been nothing that we could observe to rate the fuzzily worded letter of accusation from Mr. Burns.

MITRE has hired qualified technical personnel in a conservative but steady pattern since the nucleus of its Technical Staff —205 engineers and scientists—formed MITRE in January, 1959. At this writing our Technical Staff numbers some 450. backed up by an equal number of technical and semi-technical people as well as a conventional complement of administrative

(Continued on page 40)

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The Countdown

WASHINGTON

Choosing the Game

Once again, the Kennedy Administration is staring at the problem of establishing an overall defense structure. It must decide very soon now on the general outlines of defense forces it wants to set out the guidelines on the FY '63 DOD budget. The key questions that must be answered by the White House: Will we really expand our strategic missile forces? Will we really equip a bigger limited war force, including a million-man Army? One tip-off to the way the wind is blowing could be a decision to go beyond the 29th *Polaris* sub. And that decision should be made this fall.

Readying Abraham Lincoln

The nuclear-powered Abraham Lincoln—fifth submarine of the *Polaris* fleet—is reported to be taking aboard combat missiles in preparation for deployment. The Abraham Lincoln is understood to have launched a half dozen *Polaris* missiles near Grand Bahama earlier this month. Score: Four successes; two partials.

Cape Silo for Titan II

The Air Force is expected to have at least one of two R&D silos ready for launching *Titan II's* from Cape Canaveral in October. The first launching of a *Titan II* is scheduled for November.

Brief Stop in Moonland

The first Americans who reach the moon are going to have to be quick on their feet. NASA requirements laid down for the *Apollo* program allow only four hours for lunar exploration on the first manned mission.

Dyna-Soar: A Speed Up?

The Defense Department is expected to make its decision shortly on whether to accelerate the *Dyna-Soar* program in line with the intent of Congress in passing the FY '62 defense money bill. Meantime, an official inspection of the *Dyna-Soar* system mockup is scheduled for next month. Some 11,000 to 18,000 hours of planned wind-tunnel tests have been completed in the current program.

Who's Confused?

NASA officials are considering changing the name of the *Saturn C-3*. They feel the *C-3* designation is confusing because the *C-3* has at least two F-1 engines while the *C-1* has eight H-1 engines, thereby being quite different. And then there are all those *S* stages on the *C-3*, some of which aren't there anymore and what with the scratching of the *C-2* which wasn't much like the *C-3* either, it's really a mess.

INDUSTRY

Titan Man-hours Slashed

The Martin Co. has cut by more than two-thirds the man-hours expended in the production of a *Titan I*. The man-hour rate for early missiles was 75,000; now, halfway through the production run, the rate is 19,000. The man-hour rate for the first five *Titan II's* has averaged 35,000.

RAC Contract Due Soon

The Army is expected to sign a contract soon with its new "non-profit" company—Research Analysis Corp. The new "think factory"—successor to Johns Hopkins' ORO—is expected to take over most of the ORO personnel and occupy ORO's old headquarters near Washington. The initial contract for FY '62 is expected to run between $4 million and $5 million.

New Product Names Dept.

The U.S. Air Force, that great coiner of Space Age nomenclature, is now distinguishing between equipment and such cloudier products as system studies by the names: "hardware" and "software."

R&D Intelligence

NASA is recommending a 6-segment solid *Nova* engine (see p. 14) to the joint DOD-NASA space booster committee. . . . A solar flare observatory is being set up in Antarctica by the National Science Foundation and Douglas Aircraft. It will start operations in December. . . . Kaiser Industries reports a 1961 first half loss of $3.4 million from joint ventures in the construction of ICBM bases. . . . Russian astronomers are saying the moon would be a wonderful place to set up a telescope—no mention of missiles.

INTERNATIONAL

West German Big Missile Punch

West Germany by 1963 will have a major stockpile of missiles capable of launching nuclear warheads. Each of the West German Army's 12 divisions is expected to have a battalion of *Honest Johns;* each corps a battalion of *Sergeants*. The West Germans also will have a sizeable force of *Pershings* and air-breathing *Matadors*.

French Mail by Rocket

CNET is reported to have tested some new nose cones in recent launchings of mail rockets in the Sahara. CNET is cooperating with Latecoere in the R&D postal rocket project. The nose cones were made for new Sud Aviation *Belier* and *Centaure* rockets.

Overseas Pipeline

The Czech Army is showing off a new Czech-made antitank missile. . . . The French nuclear test site at Reggane in North Africa is to be used as an impact zone for missile warhead tests. . . . The West Germans are talking about establishing a Federal Agency for Space Research.

GENERAL METALS ACQUIRES AIRCRAFT PRODUCTS BUSINESS

General Metals Corporation, Industrial subsidiary of Transamerica Corporation, announced today that it had acquired the Aircraft products business of Gladden Products Corporation, Glendale, Calif.

William E. Butts, General Metals' President, said the acquisition includes lines of hydraulic and pneumatic components for aircraft and missile, the production of which will be continued from the General Metals Adel Division Plant at Burbank, California. Technical and production personnel engaged in their manufacture at Glendale will continue that activity for General Metals at the Adel Plant.

The other subsidiary companies of Gladden were not included in this transaction, Mr. Butts said.

Adel Division of General Metals specializes in the design and manufacture of hydraulic, pneumatic, fuel and electro-mechanical systems and power generating packages for aircraft, missiles, rockets and ground support applications. Butts said the combined operation will continue to specialize in these fields, offering products which have been developed through the experience of each company during many years.

During the past eighteen months, General Metals has completed the enlargement of its facilities in Houston, Texas and in the San Francisco Bay Area has integrated the Enterprise Division with its iron and steel facilities in Oakland. The Company's Enterprise Diesel Engine Division at Oakland produces Diesel Engines for stationary power plant and Marine application.



The Missile/Space Week

Ranger Backup Shot Set for October

NASA is planning a second *Ranger* launch in October—backup to *Ranger I* which failed Aug. 23 to go into its planned 37,500/685,000-mi. orbit.

Ranger I wound up in a 105/312-mi. earth orbit when its *Agena B* stage failed to restart as programed.

Although the flight was at first believed to be almost a complete failure, NASA officials said later the lunar spacecraft's attitude stabilization system was working perfectly. It was locking onto the sun properly and when it passed into the earth's shadow its nitrogen jets fired in a vain attempt to find the sun again.

The earth orbit, however, precluded proper functioning of the experiments aboard, which were designed to measure magnetic fields, energetic particles and their interaction in deep space. *Ranger I* was in a 91-min. orbit with an inclination of 33°.

NASA Hunts for Apollo HQ

A four-man team from NASA last week surveyed possible sites for the $60-million manned space flight center which will direct Project *Apollo*.

The team visited Tampa and Jacksonville, Fla., Shreveport and the central Louisiana area and Houston, Tex.

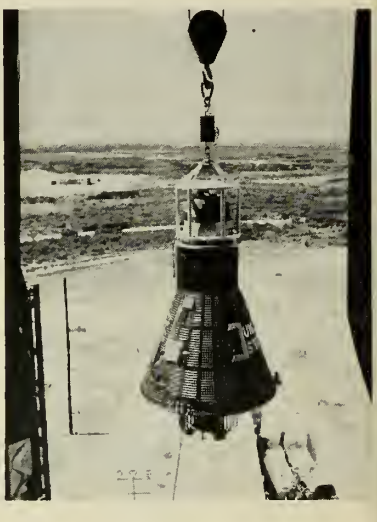
NASA officials said that other areas will be inspected, but that the team's future schedule has not been worked out.

Sixty million dollars for the new center was included in the space agency's Fiscal 1962 budget. Officials said that the site should be picked and construction work begun by the end of this year.

The center, to have 1600 employees, will be the focal point for training *Apollo* astronauts and will handle development of the spacecraft.

The NASA survey team is headed by John Parsons, deputy director of Ames Research center.

The criteria for the selection of the site includes: accessibility to water transportation, modern communications, skilled labor market, industrial complex, proximity to higher education, a land area of 1000 usable acres, and availability of interim facilities.



MA-4 Postponed Twice

The scheduled launch of the *MA-4* unmanned *Mercury* capsule (above) into earth orbit was postponed twice last week because of technical difficulties in the spacecraft.

The shot was rescheduled for Friday, Aug. 25, but space agency officials said it might be delayed until this week.

NASA officials did not divulge what specific problems forced the postponements.

Saturn Altimeter Award

NASA has awarded Ryan Electronics a contract for development and fabrication of a high-altitude radar altimeter for the *Saturn* booster.

The $450,000 contract with the San Diego, Calif., firm is to be completed within 14 months.

More Titov Data

The Soviet newspaper *Pravda* said that a large number of tracking stations were used to monitor Gherman Titov's 17½-orbit spaceflight.

The paper said ships in both the

Atlantic and Pacific were used and all calculations were carried out at several different points simultaneously by electronic computers.

It indicated that the capsule had been equipped so that Titov could have landed safely and survived in water or uninhabited locale.

Pravda also said at least two possibilities would have forced premature completion of the flight; a sudden increase in sun radiation or illness or distress affecting Titov.

The paper also published photographs of Titov, transmitted to earth by TV. Five of the pictures were taken by a camera with a narrow-angle lens, centered on Titov's face, and two by a wide-angle lens, with a view of his body and part of the chamber.

Work Stoppage Bill

A bill has been introduced in the Senate aimed at ending unauthorized work stoppages at missile bases.

Under the bill, employees who took part in walkouts, slowdowns or other concerted work stoppages not authorized by their union could be fired.

The measure was sponsored by Sen. Carl Curtis, with Sens. John L. McClellan and Karl Mundt. McClellan is chairman, and Curtis and Mundt members, of a special committee that recently held hearings on the problem.

No More MR Flights

The space agency announced last week that there will be no more manned suborbital flights down the Atlantic Missile Range.

The NASA announcement said that Project *Mercury* officials will now devote themselves to getting a U.S. astronaut into orbit late this year or early next year. (M/R, July 31, p. 16).

The agency said that all expected results of the suborbital series had been achieved and no further flights would be necessary.

It added that all seven U.S. astronauts would be considered for Project *Mercury's* first manned orbit shot.

The manned suborbital series chalked up two successful flights, one by Astronaut Alan Shepard last May 5 and another by Virgil Grissom on July 21.

Explorer Loud and Clear

NASA officials say the *Explorer XII* satellite is sending more information back to earth than any other satellite launched.

This stems from the satellite's highly elliptical orbit which permits it to be in contact with ground stations for far longer periods than other orbiting spacecraft.

The satellite—launched August 15—is designed to study the Van Allen radiation belts and energetic particles in space. Officials said it would be about two weeks before data on the radiation belts can be analyzed.

Orbiting period of the satellite is 26½ hours. Its apogee is 47,800 miles, its perigee, 180 miles; and its inclination is 33.3 degrees.

Officials estimated its life at one year, at least. Three similar satellites will be launched over the next 2½ years.

Shots of the Week

• A *Polaris* was destroyed 33 seconds after launch when it veered off course after being fired from the U.S.S. Observation Island. It was the third straight failure of the advanced *A2* in a shipboard launching after three successes.

• The Army's *Pershing* had its 17th successful launching as Army Secretary Elvis Stahr looked on.

• A SAC crew successfully launched an *Atlas* from Vandenberg AFB. The Air Force said the 576th missile squadron "fully demonstrated" their proficiency.

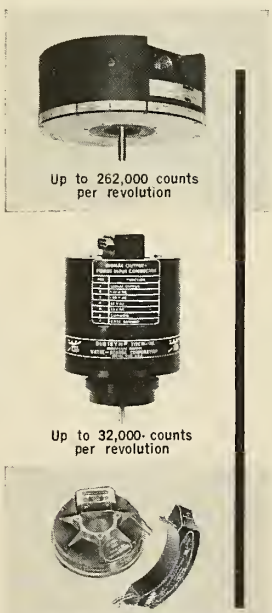
New Nortronics V.P. Named

The Northrop Corp. has appointed William F. Ballhaus executive vice president, and named Frederick Stevens vice president and general manager of its Nortronics Div., succeeding Ballhaus.

Stevens has been vice president and manager of Nortronic's Electronic Systems and Equipment Dept.

Ballhaus, a vice president of Northrop and general manager of its Nortronics Div. since August, 1957, joined the company in 1953.

Both men are graduates of Cal Tech.



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BROOKS *of House.*

Concern is growing...

Will Congress Regulate

Influential members are asking whether DOD's annual $325-million investment in such firms really cuts costs

ALTHOUGH NOT outwardly apparent, congressional concern over the expanding role of non-profit corporations in government research and development programs is continuing to mount.

The outlook: Public hearings later this fall or early next year and congressional recommendations for some form of federal regulation.

The principal congressional committee currently digging into the operations of the "non-profits" is the House Committee on Science and Astronautics, headed by Rep. Overton Brooks (D-La.). Several other important committees—particularly the powerful House Defense Appropriations Subcommittee —are keenly interested.

Meantime, the Bureau of the Budget is proceeding with its own study of the "non-profits" in line with a directive issued earlier this month by President Kennedy. The study is due before Dec. 1.

Congressional hearings on "non-profits" had been expected late this summer. However, preoccupation with the Berlin crisis, the increased space program and other matters forced Congress temporarily to put the "non-profits" question aside.

The Administration's inquiry could bring about a further postponement until the inquiry is completed. There is some feeling in Congress that this is one of the major reasons why the inquiry was ordered.

The President's directive to David Bell, Budget Bureau director, said that he should specifically look into:

—"The effect of the use of contractors on direct federal operations, the federal personnel system, and the government's own capabilities, including the capability to review contractor operations and carry on scientific and technical work in areas where the contract device has not been used, and policies and actions needed to increase the government's capabilities in these respects."

—"The policies, if any, that the government should follow in controlling the salaries and fringe benefits of personnel working under a contract and the appointment of management and dismissal of such personnel . . ."

In general, the President said: "I would like to have full consideration given to the limitations which make direct federal operations difficult and to the development of proposals for adjustments and new concepts in direct federal operations which would provide the government with greater flexibility in determining whether the public interest would best be served by the use of contractor or direct government operations."

• **Burning questions**—Through the foggy sentences, the President raised two of the main questions that are being increasingly asked by congressmen: What effect is the salary structure of the "non-profits" having on industry and the Civil Service? Is the public interest being served in accomplishing tasks more competently at reduced cost?

The directive appeared to pass over several other equally significant questions that are being raised on Capitol Hill.

One of these is whether the "non-profits" could be or are being used for the dissemination of proprietary information among defense contractors. Another is whether "non-profits" could be or are being used to "wire in" subcontracts for contractors.

• **The investment**—The total value of all Defense Department contracts to non-profit corporations and institutions of various types is running today at about $325 million a year.

This figure includes everything from contracts with universities—where the contract is incidental to the institution's primary operations—to companies such as Aerospace Corp. which were created solely to handle government assignments.

Further refinement of this figure is made difficult by the many gray areas involved. However, some fairly firm figures are available.

The bulk of the non-profit contracts are awarded by the Air Force. In FY '62, the Air Force expects to award a total of about $198 million in contracts to non-profit companies and organizations.

More than half of this—$107.9 million—will go to six contractors: RAND, ANSER, Lincoln Laboratory, MITRE, STL and Aerospace.

The Army and Navy combined are expected to award at least some $30 million to non-profit companies and organizations.

However, these figures for the three services do not include many of the university research contracts or contracts let by ARPA or the Office of the Secretary of Defense.

Another way to get at how much of the defense budget is going to non-profit companies is by separating the contracts that are awarded to so-called "captive" organizations and those organizations that handle federal projects as only part of their total activities.

The total value of all defense contracts going to the former are now running at about $153 million a year. Of this, about $35 million is going for operations research—the "think factory" group.

• **Really necessary?**—Critics of the "non-profits" contend that most of these contracts are unnecessary; that the same job could be done cheaper and better

Non-profits'?

by James Baar



I. GETTING
Aerospace President.



C. W. HALLIGAN
MITRE president.



F. R. COLLBOHM
RAND president.

by the services themselves and by private industry.

The services and the Defense Department contend that they could not; that truly objective studies and advice can not be obtained from hardware manufacturers and that a sufficient number of technically qualified people cannot be retained within the salary structure of the government.

Critics contend that the "non-profits" have hired technically qualified staffs by raiding industry and the government—and thereby driving up the salary scale in industry.

The "non-profits" and the services contend that the "non-profit" organizations' salary scales are based on the going rates in private industry; that only a relative few people have transferred from the government to the "non-profits;" and that in many cases men have switched from industry to the "non-profit" companies at great financial loss.

Critics contend that the operations of the "non-profits," far from costing less than they would if performed by private industry, actually cost more. This contention is based on a charge that because the captive companies are "non-profit," their costs are not suspect and, therefore, tend to be excessive.

The "non-profits" and services insist that all costs are closely watched. However, some tentative studies show that costs by "non-profits" are seldom disallowed.

• **Chief target** — Unquestionably, the "non-profit" company under the greatest fire in recent months has been Aerospace Corp., the Air Force's successor to STL, and principal technical adviser on missile and space R&D programs. It has a staff of more than 2600 employees. Plans call for nearly doubling the staff in the next 18 months.

The Air Force requested $35.2 million for Aerospace Corp. for FY '62 in the budget submitted to Congress. During FY '61, Aerospace received $26.4 million, covering its initial organization period.

The House Defense Appropriation Subcommittee slashed $5 million from the Air Force request and bitingly said in reporting out the defense money bill:

"The Committee feels that the salaries paid by the Aerospace Corp. are excessive; that its overhead costs are too high and that it plans to employ too large a staff. The Air Force should either be able to obtain its required services from Aerospace Corp. for $30.2 million or find another method of coping with the problems involved."

The Defense Department accepted the cut in soothing tones and Congress sustained it on the floor.

Nothing since then appears to have changed the attitude of Congress toward the "non-profits." ⌘

	FY '62 (Millions)
RAND	$ 11.6
ANSER	1.0
LINCOLN LAB	15.3
MITRE	15.0
STL	34.8
AEROSPACE	30.2
OTHER	about 90*
TOTAL	197.9

*Divided among approximately 240 non-profit contractors.

AIR FORCE BUDGET *for "non-profits" is almost ⅔ of total $325 million spent by Pentagon in Fiscal Year 1962.*

Salaries	Aerospace	APL	Assoc. Univ.	IDA	MITRE	RAND	Lincoln Lab
$75,000	1						
50,000-75,000	1					1	
35,000-45,000						2	1
27,500-45,000	4				1		
30,000-40,000				5	2		1
20,000-33,000	13						7
25,000-30,000		1	2	9		2	
22,500-30,000					6		
21,000-28,000	5						
22,000-26,500							6
20,000-25,000	9	13	12	26			
Total above $20,000	33	14	14	40	9	5	15

SALARY SCALES OFFERED *by "non-profits" constitute a principal target of congressional criticism. These figures, based on official studies, show the number of persons in various salary brackets at some "non-profit" firms.*

Will liquid Nova slip? . . .

Big Moon Booster Decisions Looming

NASA prepares to pick lunar launch site, release specs for Nova-type solid, study liquid Nova proposals

by Hal Taylor

SPACE OFFICIALS are edging closer to three key decisions affecting big booster systems for the U.S. lunar program.

• Within the next 30 days NASA is expected to designate a launch site for moon vehicles. First choice is Cape Canaveral; the east coast of Georgia is second.

• Wraps will be taken off the specifications for the *Nova*-type solid booster at a bidders conference in late October or early November.

• Design studies for the F-1 engine-powered liquid *Nova* vehicle are due to be submitted to NASA in September. The studies were made by North American, Lockheed Aircraft Corp. and General Dynamics/Astronautics. NASA hopes to award the hardware design contract by the end of the year.

This timetable is threatening to build some slippage into the liquid *Nova* development. The F-1 engine was fired Aug. 16 for the 19th time at thrust levels over 1 million lbs.—indicating it is meeting its schedule for on-time delivery in early 1963. There are estimates that it may take 24 to 30 months to produce the vehicle, which would push back the first flight tests into 1964—a year after the F-1 is ready.

Some officials are indicating, however, that the F-1 may be put to work in the *Saturn C-3* in 1963, which would take up the slack.

• **Site survey**—A NASA survey team conducted its last tour of proposed launch sites for the *Nova* vehicle last week. Besides Cape Canaveral and the Georgia coast, other areas considered seriously were the coast of Texas and White Sands Proving Grounds, N.M.

White Sands was ruled out because there is no water access to it. The Texas site lost favor because launchings from it would fly over inhabited land masses.

The survey team's final recommendations are expected to be in the hands of NASA administrator James Webb sometime this week. Most NASA officials favor Cape Canaveral because of its existing tracking and ground facilities. On the other hand the Georgia site would prevent overcrowding Canaveral's launch facilities while still permitting use of the Atlantic Missile Range tracking system.

Whichever site is selected, NASA officials expect to spend from $25 million to $50 million on land acquisition.

While the question of whether one launch site can be used for both the solid and liquid versions of *Nova* has not been resolved, the setting of a date for a bidders conference on the solid engine awaits only a decision as to its specifications by a joint NASA-DOD committee on launch vehicles.

It had been hoped that the conference could be held in October, but the decision of the committee—expected in about seven weeks—may delay it for a short while.

• **Segmented solid**—NASA has recommended the committee approval of the following specifications for the solid first stage:

• Eight clustered engines with a thrust of 2.5 million lbs. each for a total first-stage thrust of 20 million lbs. Each engine would have six segments.

• The stage would have an overall length of 120 ft. and each engine a diameter of 160 inches. Total diameter of the stage would be 45 ft.

• Gross weight of each engine would be 1.3 million lbs., for a total weight of 10.1 million lbs. Each segment would weigh 231,000 lbs. Total weight of the four-stage vehicle would be 12.2 million lbs.

• It would be able to boost a payload of 170,000 lbs. to escape velocity.

• Stage burning time would be 100 seconds.

Certain space officials have called for a wider diameter for each engine with a resulting cut in the number of engines in the stage. This is being studied by the committee.

Development of the solid version of *Nova* would have gone a lot faster if more money had been made available. For instance, there is a decided lack of money for such things as designing the stage, studying the question of the interaction of the solid stage with the rest of the vehicle and the development of a guidance system. As a result, much of this work will be put off until money is obtained in Fiscal 1963 appropriation bills.

The space agency has not yet released much information concerning the specifications for the liquid version of *Nova*. This apparently is because the three design studies have not been completed and no decision has been forthcoming from the joint agency launch vehicle committee.

Reportedly, it is quite possible that

A New Medium Booster?

NASA IS entertaining the possibility of building an entirely new medium-thrust space booster to replace Thor *and* Atlas.

First step in this direction was the award of a six-month contract to Space Technology Laboratories Inc. last week to study the payload capabilities of existing medium-class vehicles with respect to future satellite and space probe requirements.

It is understood the study was motivated by a belief within NASA that it might be cheaper to develop an entirely new vehicle than to continue using Thor Agena B *and* Atlas Agena B.

Thors *and* Atlases, *depending how they are modified, are reported to cost NASA anywhere from $4-6 million apiece. This does not include developmental costs, which were paid largely in their R&D as missiles.*

To get under $4 million and amortize R&D as well, any proposed new space booster would probably have to be either solid- or storable liquid-fueled. It also would have to be planned for an extremely long production run.

Other factors which influenced the NASA study apparently are growing problems with mating spacecraft to Thor *and* Atlas *and a conviction that a rocket designed from the "ground up" as a space booster would be more reliable.*

NASA will first award a design contract for the stage before the end of the year and then award a contract for its production later.

The liquid-powered F-1 engine will have a thrust of 1.5 million lbs. How many engines will make up the first stage still has not been decided.

Dimensions of the liquid version are expected to approximate a total height of 340 ft. The first stage will be about 45 ft. in diameter, second stage 35 ft. and third stage about 27 ft.

Present plans call for test-flying both liquid and solid versions before reaching a final decision as to which will be used to boost the *Apollo* spacecraft to the moon.

• **F-1 for Saturn C-3**—Information turned up by MISSILES AND ROCKETS' West Coast Bureau indicates that NASA is expecting to move quickly on the *Saturn C-3*, which is to be powered by two F-1 engines.

Erich Neubert, the Marshall Space Flight Center's associate director for R&D, says while the *C-3* will not have the *Saturn C-1* eight-tank booster configuration, it would be designed for almost the same burning time. This indicates greatly increased tankage and, therefore, external size—spelling a requirement for new or drastically modified ground launch facilities.

Neubert maintains that the F-1 will not sit in a warehouse for any substantial period after delivery. The *C-3*, it is claimed, can be ready for mating with the F-1 when the engine is delivered, presuming the go-ahead is given by the expected date of January 1. This means that NASA must firm the *C-3* design, modify tooling, begin metal work, test the structure in many ways, and have the vehicle ready for test—all within the twelve months available before the F-1 delivery.

The *Nova* vehicle itself, Neubert said, would take about 24 to 30 months to design and build, if past vehicle-design experience holds true. There was no explanation why *Nova* would take at least two years, and the "completely new" *C-3* could be ready in one year.

Apparently referring to Soviet success with *Vostok II*, Neubert said: "No event will push development of F-1 or *Nova* at the sacrifice of reliability".

Some observers see a possibility—albeit remote—that future developments in solids might conceivably leave the F-1 engine in the same situation as Rocketdyne's E-1, which was begun as a research engine to see if rockets of half a million lbs. thrust were feasible.

As the E-1 proved the feasibility, there was some slight effort made to design a vehicle to take advantage of then-existing hardware and tooling. However, no vehicle was designed and the E-1 died without ever flying. ⁂

WESCON Speaker for Active ComSats in Stationary Orbits

by Charles D. LaFond

SAN FRANCISCO—Stationary-orbit active satellites must become the backbone of future global telecommunications.

Excluding special military requirements, passive satellite communication systems will never be economically competitive with high-capacity active satellites.

These findings were presented here last week before a technical session of the 1961 Annual Western Electronic Show and Convention (WESCON) at the Cow Palace.

S. G. Lutz of Hughes Research Laboratories, Malibu, Calif., supported his argument with a list of 12 significant advantages—seven economic and five technical—for the stationary-orbit active system. He conceded that there are space-technology and propagation-delay problems to be overcome; and he emphasized the need for more planning and regulation of the stationary satellite communication systems.

Lutz stressed that his study concentrated on commercial, high-volume, common-carrier satellite systems and on their governmental point-to-point counterparts. Further, he assumed the ultimate goal of achieving the most communications per system dollar spent.

• **Components galore** — The continuing hold of small-components exhibitors in the great Cow Palace was never more evident. There was only a sprinkling of system-type displays—these being a few missile systems, space chambers, and major computer and guidance subsystems.

The available 1170 booths were filled to capacity by more than 800 exhibitors.

Attendance during the four-day meeting was expected to exceed 36,000.

To heighten interest throughout the 42 technical sessions, panels provided enlightened critiques of each paper. In general, three papers were delivered in each session, for a total of over 120 topics.

By M/R's press time, considerable interest had been generated by a special "Arms Control" discussion. The two-hour night session was scheduled to provide five nationally known authorities covering each critical area of the subject: technical, military, politico-economic, psychological problems, and nuclear consideration.

Dr. L. C. Van Atta, former special assistant for arms control to the Director of Defense Research and Engineering, was to chair the panel. Other panelists included Dr. W. H. K. Panofsky, Stanford University; Rear Adm. P. L. Dudley, Joint Chiefs of Staff; Harry Rowen, DOD; Dr. D. G. Brennan, MIT's Lincoln Laboratory; and Dr. C. E. Osgood, University of Illinois.

• **Satellite communications** — Lutz eliminated military communication satellites from his argument for several reasons:

—The *Courier*-type low-orbit memory satellite offers military security advantages that far outweigh commercial limitations.

—*Echo*-type passive systems are virtually non-jammable.

—The Project *Needles* (orbital chaff) approach appear virtually indestructible.

—Active non-stationary systems employing high power densities or the equivalent in correlation coding offer advantages for communication with vehicles (but at a sacrifice in data capacity and frequency-sharing ability).

—Finally, he said, while commercial systems evolution can be predicted with a reasonable accuracy, new military requirements or new techniques for satisfying military requirements could at any time invalidate predictions of ultimate military systems.

• **Passive systems countered**—Lutz believes the immunity of passive satellites to electronic failure is an advantage easily overemphasized.

Active systems, he asserted, can be competitive with present transoceanic cables even if satellites are replaced on an average of once a year.

Further, he said that Bell Telephone Labs is now designing a satellite-travelling wave tube which will have an 18-year life expectancy. Submarine cable repeaters have already shown similar operating life without tube failure.

The problem with passive satellites —as with non-repeater submarine cable in the past—is the intolerable system cost per circuit.

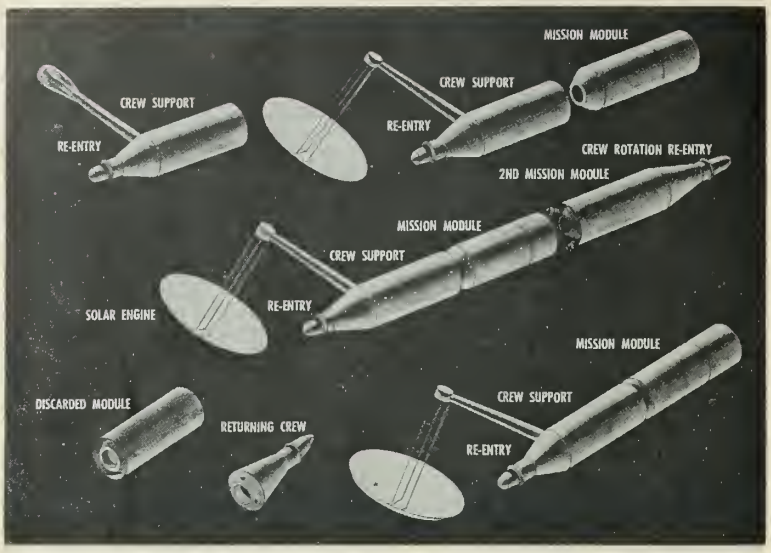
While it is true, he said, that passive satellites offer higher capacity per dollar in orbit, the real cost is reflected in the shift of electronic burden to ground terminals and resultant higher total cost. ⁂

Correction

Roy P. Jackson of Ford Motor Co.'s Aeronutronic Division, Newport Beach, Calif., who heads the company's Saturn project team, was incorrectly identified as Johnson in last week's COUNTDOWN.

Available by '63 . . .

DEIMOS Manned System Is Described



MARTIN ARTIST'S CONCEPTION shows sequence of DEIMOS system from rendezvous and closing of first crew and mission module (top) through crew replacement.

DENVER—Details of Project *DEIMOS,* a manned space logistics system which could be operational by 1963, have been disclosed here by Martin-Denver.

The system has been proposed to the Air Force as an interim step to such systems as *MTSS (Manned Test Space Station), SLOMAR (Space Logistics, Maintenance and Repair)* and *SMART (Space Maintenance Repair and Techniques).* Company sources report initial Air Force reaction as favorable, and a detailed technical report now is being drawn up for presentation to the Air Force and Department of Defense late this year.

Sundstrand Aviation and Hughes Aircraft are working actively with The Martin Co. on the proposal. Since the project calls for use of a scaled-up two-man *Mercury* capsule, Martin also has discussed it with McDonnell Aircraft.

DEIMOS is a company acronym for Development and Investigation of a Military Orbital System. It also is the name of the second moon of Mars.

• **Railroad style**—As described by Dr. Carl Kober, director of advanced technology at Martin-Denver, *DEIMOS* is an effort to standardize a space logistics system on a "railroad" concept. It would employ standard "freight cars" and "passenger cars" with standard couplings to carry varying payloads into orbit. Once there, they could be assembled into what might be called a space train.

Booster for the system would be a modified two-stage *Titan II.*

"Since this is not an ambitious program, we could begin flying in the middle of 1963, employing a two-man *Mercury* capsule," Dr. Kober asserts. To achieve this date, hardware development would have to begin this year.

With modification, *Titan II* is believed to be capable of putting into 300-mile orbit a capsule of approximately 10,000 lbs. This would be unit weight of the passenger and freight sections.

Astronauts could be shuttled back and forth to the space train when desirable.

"The technology is ripe and mature enough to do this," Dr. Kober says. A big advantage of the system, Dr. Kober points out, is that no need exists for new hardware—both *Titan II* and the *Mercury* capsule are available.

• **Making connections** — Coupling in space offers the major problem to be solved in the system. First requirement in this is accurate rendezvous. Dr. Kober dismisses the rendezvous problem as over-stated.

"It is easier to do than aerial refueling," he asserts.

A tougher problem is that of sealing against a vacuum so that the crew of the space train can move freely from one module to another. The requirement also calls for the ability to break the seal and re-use it in space when necessary.

Now in the preliminary design phase, the seal interestingly enough is based on the same general principle as a railroad coupling pressure hose.

Rendezvous problems of the system are being worked out at Hughes Aircraft. Sundstrand is working on a solar-drive turbo-generator for the system.

The solar concentrator would be extended on the end of a long arm. Its deployment technique calls for inflation of a balloon, rigidization by foam injection, and burnoff of the balloon.

The resulting aluminized Mylar reflector would have a parabolic surface of revolution with a 60-deg. rim angle. Deployment time is estimated at 23 min.

The system is designed to supply 5 kw continuously for at least one year, at an 0.95 reliability factor. Its weight is estimated at 465.8 lbs.

• **Salt for storage**—Details of the power system released by Sundstrand show the unit employing a heat exchanger designed to minimize solar re-radiation from the cavity mouth while transferring solar heat efficiently to both lithium hydride and sodium fluoride for subsequent transfer to the working fluid (rubidium).

Sundstrand says the molten salts serve to store sufficient thermal energy to continue boiling and superheating the rubidium during transit through the earth's shadow.

The four-stage axial flow turbine directly drives an electromagnetic alternator and coolant/condensate pump at 24,000 rpm. A circular plate condenser is used in recovery, with the condensed liquid separated from the vapor by the centrifugally created gravity. It is recovered by coolant-powered jet induction pumps at the rim, then returned to the coolant/condensate pump.

Sundstrand has developed the powerplant under an Air Force Systems Command contract aimed at proving out feasibility of solar power units of up to 15 kw. ⁂



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Electromechanical Systems by **Autonetics** *Division of North American Aviation*

Technical Countdown

ELECTRONICS

Light Overtones Obtained from Laser

Using a Laser beam which produces a power density of 100 million watts per square centimeter at the focus, four University of Michigan scientists have—for the first time—produced an overtone of a beam of light. The experiment produced the second harmonic (or overtone) of red light by focusing the Laser's intense beam of red light into a quartz crystal. As a result of the extremely high intensity of the red light at this focus, the blue light was produced in the crystal in much the same way overtones are produced in music.

Sensitive IR Device Being Built for Navy

An infrared detector—so sensitive that it felt fractional changes in the moon's surface temperature during an eclipse—is being built for the Navy by Hughes Aircraft Co. At the heart of the device is a miniature refrigerating device which keeps the IR detector at its operational temperature of −452°F. The refrigeration unit—a closed cycle liquid helium cryostat—employs a Claude-type thermodynamic cycle to cool the helium refrigerant gas to a temperature at which Joule-Kalvin cooling may be used.

Photo Tachometers Measure Missile Model Spin

The Naval Ordnance Laboratory has developed several phototransistor tachometers to accurately measure the spin rate and decay rate of spin of missile models revolving as slow as two rps. in a supersonic wind tunnel. Consisting of a light source, a phototransistor and a perforated wheel or some other means of interrupting the light beam shining between the first two components, the tachometer's phototransistor senses the series of light pulses passing through the perforated wheel and changes its resistance accordingly. This yields a series of electrical signals which are counted per unit of time to determine the model's spin rate.

Testing of Gyro Torsion Rods Improved

An extremely sensitive system of calibrating gyro torsion rods—up to 37 times as accurate as the method previously employed—has been developed by Western Electric. The rod is inserted into the center detail of an inertia disk and turned 180 degrees. Suspended on a holding fixture, the disk is locked into position. When it is manually deflected to cause the rod to oscillate about the vertical axis, the reflected light from the oscillating disk activates an electronic counter which displays the ten-period average of the torsion rod and inertial disk. If this average falls into the proper range, the rod is passed on to the gyro assemblies.

OPTICS

Optical Tooling Improves Machining Tolerances

A high-precision optical tool for checking angularity and alignment of machine tools has been developed by the Michigan Tool Co. In effect a 360-sided optical polygon, the multipurpose tool can optically check for alignment and angular spacing in any multiple of full degrees. Working on the principle of autocollimation, the optical system measures the amount of deviation between the reflected image and the graduated crosshairs in the sighting device and gives a geometric check on misalignment, parallelism, angularity, etc.

ADVANCED MATERIALS

Cesium Market Growing

The increasing use of cesium in propellants will hit its highest point in 1963, when *Centaur* series tests are initiated. Chemalloy Minerals, Ltd., disclosed that each engine uses about 1000 lbs. of the element and the Mars shot scheduled that year with an ion engine will use about 2000 lbs. The firms has over 300,000 tons of pollucite ore in reserve at Bernic Lake in Manitoba. Assays indicate a 25% extractable cesium content.

Beryllium Sheet Development Extended

An Air Force cost-sharing contract totaling $255,000 has been awarded to Brush Beryllium Co. to continue the development of production techniques for aircraft-quality beryllium sheet. Surface finish will be emphasized. Fifty sheets, measuring 48 by 18 in., will be produced in the final production phase of the contract.

Space Effects Studied

The effects of extended space mission on non-metallic materials will be investigated by the Martin Co. under a $52,000 NASA contract. The main characteristics simulated will be vacuum and radiation. Loss in weight, evaporating molecular types and changes in strength will be checked.

Coated Fibers Studied for Satellites

Fabrics normally found in window curtains are being studied for the AF Systems Command for possible use in expandable, rigid satellites such as communications spacecraft or solar collectors. The study—being conducted by Westinghouse—is concentrating on fiberglass yarns, because of their temperature resistance and dimensional stability. A serious drawback to glass fibers—and one that will get the closest scrutiny—is the tendency for the fabric to wear out when it rubs against itself or against some other surface.

Temco's 'Shear-forming' Wins Army Contract

A sophisticated metalworking process called "shear-forming" was the principal reason behind the award of an Army contract to Temco Electronics, a subsidiary of Ling-Temco. Awarded to the company for the production of afterbodies for the *Davy Crockett*, the pact was based on demonstrated proficiency. "Shear-forming" changes a flat metal square into a cone in minutes by mounting the metal square on a shaft and rotating it under force from one side until the square gradually closes over a shaft-mounted male member. The resulting cone is uniform and seamless.

ASW & SEABORNE SYSTEMS

Underwater "Jeep" Acquired by Loral

With the addition of Dr. Dimitri Rebikoff to its staff, Loral Electronics Corp. has acquired rights to the T-14—an underwater vehicle which is termed the "jeep of the deep." Fabricated of corrosion-proof, lightweight aluminum and equipped with a control system enabling it to dive, loop, climb, and roll under water, the craft is only 9½ ft. long, less than a foot wide, and weighs only 180 lbs., fully equipped. The T-14, which operates at a constant speed of 3 knots for up to 2 hours at depths down to 230 ft., is designed for oceanographic research.

U.S. Seeks Oceanography Instruments

Industry told it must turn out inexpensive, rugged and accurate devices to support expanding effort; Navy to buy $46 million worth.

by William Beller

A GOVERNMENT COMMITTEE charged with rapidly developing America's knowledge of the sea has called upon industry to come up with the instruments that will be needed to do the job.

Suppliers of the oceanographic instruments will be well compensated. The Navy alone will spend some $46 million on such devices during the next decade—$1.5 million as a starter during this fiscal year. This will be part of the more than $900 million the Navy recently announced it will invest in oceanography from now through Fiscal 1970.

The money going into oceanographic work is fast increasing. Various government agencies have earmarked a total of $97.5 million for Fiscal '62. This is $44.5 million more than was spent during the last fiscal year.

This build-up is part of the national effort in oceanography proclaimed by President Kennedy in his inaugural speech and detailed in a message to Congress on March 29.

Adding urgency to the drive are reports that the Soviet Union has a fleet of 150 oceanographic ships—twice the number the U.S. has. Her fleet is known to include the world's only nonmagnetic ship, the Zarya, and a research submarine, the Severyanka.

• **Toward "meaningful program"**—The Interagency Committee on Oceanography (ICO) was set up by the Federal Council for Science and Technology in January, 1960, as a permanent committee within the Council. ICO's purpose is "to provide a coordinating mechanism among all government agencies engaged in oceanographic activities for the development of a meaningful national program."

To do this work, ICO has representatives from the Departments of Defense; Commerce; Interior; Health, Education and Welfare; State and Treasury, as well as the Atomic Energy Commission and the National Science Foundation.

ICO sponsored the government-industry symposium on oceanographic instrumentation, held in Washington, D. C. on Aug. 16 and 17. Here, nearly 700 industry and government representatives were briefed on the government's needs.

They were told that the instruments they come up with must be not only economical but rugged, easy to maintain and accurate. This is an old cry of all instrument users, but every speaker at this symposium sounded it with special emphasis.

Rear Admiral Charles Pierce, U.S. Coast and Geodetic Survey (Ret.), observed that skilled electronic and mechanical personnel needed to service complex instruments are hard for industry to recruit, train and hold on to —and that the problem is vastly more difficult for the Navy. He lamented that "the prevailing lower pay rates, long periods away from home and frequently crowded living conditions aboard ship are not conducive to retaining sea technicians aboard long enough to get their '20-year service pins.' "

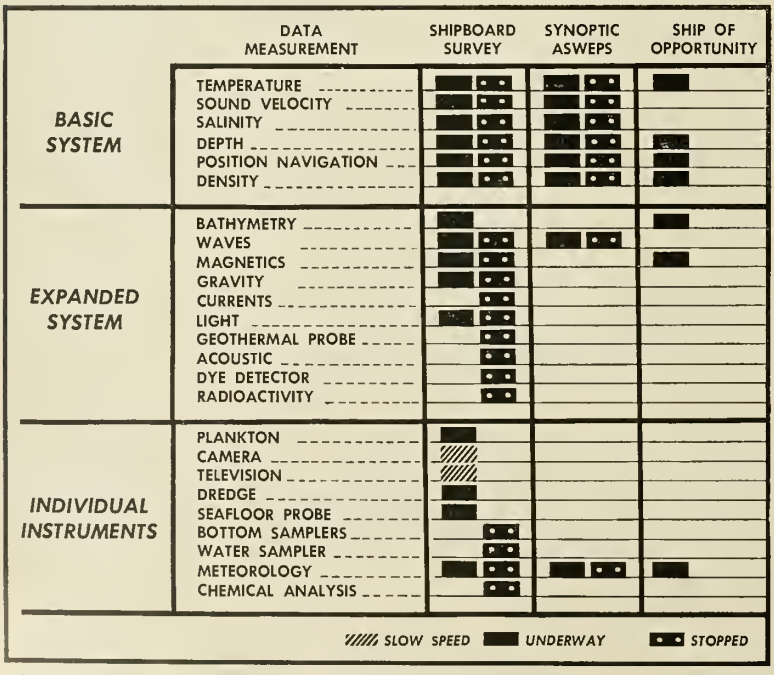
• **Work to be done**—Pierce complained that we have not scratched the surface in developing instrumentation for the tasks confronting oceanographic survey and research ships. He also noted that the cost of these ships is mounting steadily—a 3000-ton ship sometimes costing $3000 a day to operate.

Amplifying Pierce's point, Captain R. D. Fusselman, deputy hydrographer of the Navy's Hydrographic Office, said that it takes one ship 24 hours to complete what is referred to as "an oceanographic station." This means measuring and observing possibly two dozen physical, chemical and biological characteristics of the sea at a specific location.

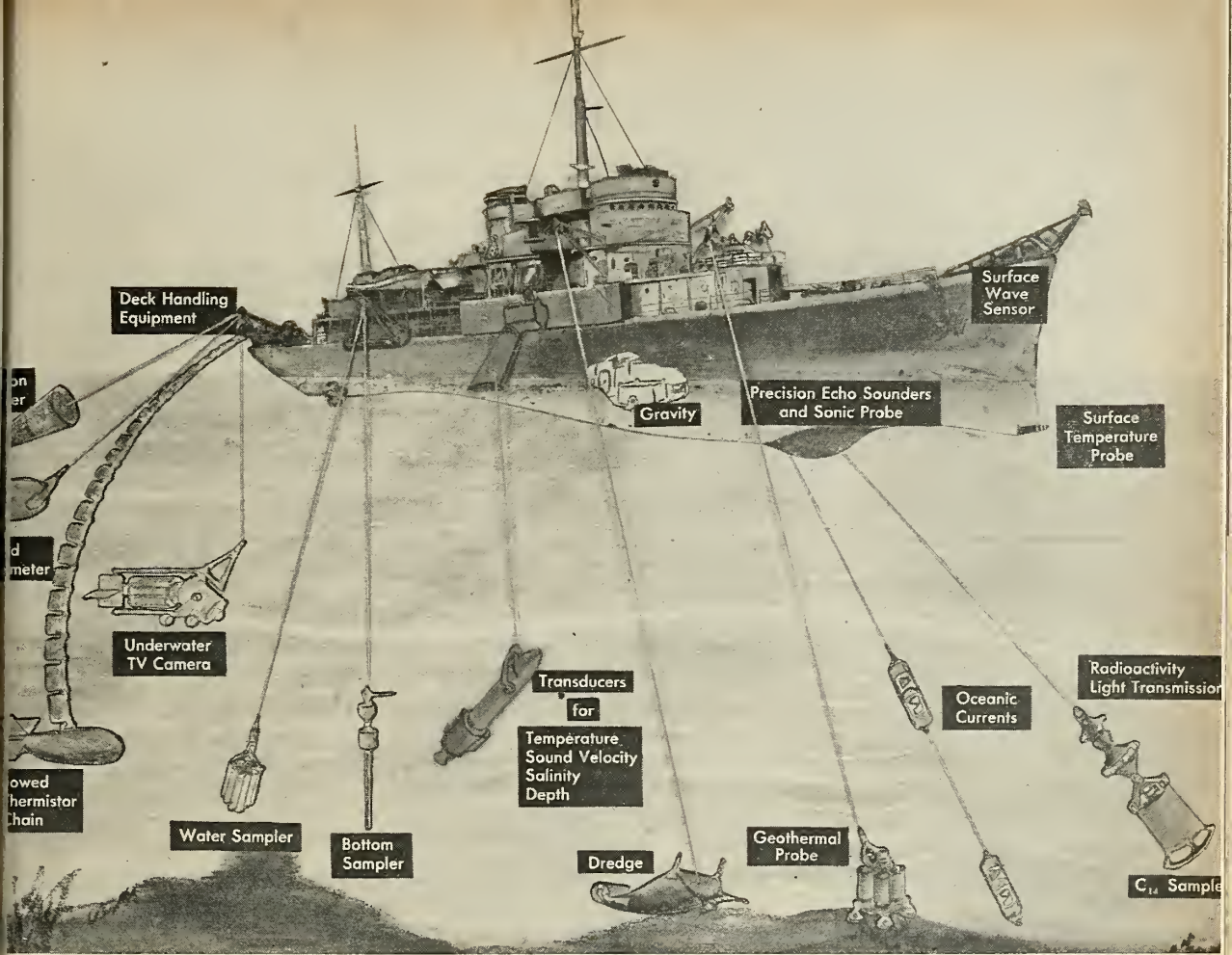
"Our objective is to reduce this time to two hours," Fusselman announced.

Another possible way to reduce the unit cost of oceanographic data gathering is to use aircraft and buoys to a greater extent. Aircraft would be by far the cheaper method—if suitable airborne oceanographic instruments were invented.

On the other hand, the problem of devising instruments for fixed buoys is



"OCEANOGRAPHIC SURVEY INSTRUMENT SUITS" required by Interagency Committee.



TYPICAL COMPLEMENT of instruments on present-day oceanographic research vessels.

much simpler. Yet the present designs of buoy systems are said to be naive and intuitively arrived at.

• **Water costlier than Scotch**—There are now only about 50 to 75 fixed, ocean-resistant scientific buoys on site for the U.S. Tens of thousands would be needed to probe the oceans.

The cost of operating buoys on a per-unit-of-data basis appears to be relatively low. An ardent buoy backer, Dr. William S. Richardson, scientist at the Woods Hole Oceanographic Institution, uses as a basis for comparison the cruise of a relatively small research vessel which during the International Geophysical Year made several Atlantic crossings in a little under four months. He maintains that this was an economical cruise in which shore leaves were few and no one charged the expedition for a flight home.

The chief measurements made were of ocean temperature and salinity. Exclusive of the price of the instruments, the average cost of each measurement was $21.75. Another example on the same trip showed that to capture a liter of water in a Nansen bottle cost $16.30 —which Richardson carefully noted converts to $11.70 a fifth, more than the price of 25-year-old Scotch.

By contrast, if a ship were to take the same length of time servicing a line of buoys, Richardson feels that the operation would be far more economical. For example, on the basis of actual operations the measurements of ocean current came out to cost 50¢ each. He predicted that refinements in technique and instruments could probably bring the cost down to as low as a dime a measurement.

A document of high interest and value to everybody in industry concerned with oceanographic instrumentation was released at the symposium—"Required Oceanographic Suit for Oceanographic Survey Vessels."

This 51-page description of the government's needs had its beginnings last October when the Hydrographic Office published special publication Number 41, entitled "Oceanographic Instrumentation." Then the following month, at a joint Office of Naval Research-Hydrographic Office meeting in Washington, D. C., 40 oceanographic experts further clarified the instrumentation needs. It was their final report that was given out.

At the same time, the Hydrographic Office distributed two similar documents, one for oceanographic instrumentation for ships of opportunity and the other for synoptic ships. ⌗

Approximate Number of Instruments Required for Research and Survey Operations

BASIC SYSTEMS	
ASWEPS	*45*
Ship of Opportunity	*56-163*
Survey/Research	*42-69*
EXPANDED SYSTEMS	
Survey/Research	*50-100*
INDIVIDUAL INSTRUMENTS	
Survey/Research	
Plankton	*41-52*
Camera	*42-88*
Television	*25-60*
Dredge	*41-52*
Seafloor Probe	*40-65*
Bottom Samplers	*41-52*
Water Sampler	*62-130*
Meteorology	*52-93*

Details of Ranger Instrumentation

THE LUNAR LANDING capsule for *Rangers 3, 4* and *5* is expected to contain a seismometer with accompanying amplifier, transmitter, antenna and power supply, a righting mechanism, temperature control system, zeroing motor and automatic calibration system.

The zero motor and calibration system are recent additions. The program is still reasonably fluid, and there may be other additions or deletions of equipment before the first capsule launch.

Jet Propulsion Laboratory is prime contractor for NASA's Project *Ranger*, Aeronutronic Division, Ford Motor Co., is capsule contractor, and Hercules Powder Co. will make the retrorocket.

The entire package weighs 900 lbs., including retrorocket. The actual instrumentation package for lunar landing weighs about 90 lbs. after separation from retrorocket prior to impact. A balsa wood "cushion" (M/R, June 19, p. 42) will provide impact absorption at optimum 30 meter per sec. velocity. Variations in retromotor performance may produce impact speed ranges as high as 70 meters per sec., for which balsa design also provides impact protection.

• **Shell layers**—Balsa was selected after studies of materials offering best crushing strength per pound. The problem of designing and fabricating an outside sphere from end-grain balsa was solved by covering the innersphere with a "jig-saw" pattern of precision-shaped balsa sections that fit so that only end-grain sections are exposed. Careful bonding of each section to adjoining sections provides maximum shock absorption from any direction.

Inside the balsa shell is a plastic "outer" shell. A thin layer of flotation fluid separates the plastic shell from the still-smaller inner metal sphere. Because of the temperature environments expected, it is assumed that the fluid is a refrigerant, such as freon, which will maintain low viscosity properties.

The floating feature permits the inner sphere and contents to rotate independently of the balsa-covered outer shell once a caging pin has been disengaged by the landing shock.

The main assembly inside the sphere has a center of mass below the flotation center, enabling instruments and antenna to slowly sink and come to rest aligned along a radius from the center of the lunar mass.



IN EARLY TEST of Ranger capsule, it was dropped from altitude of 1000 ft. to macadam surface. Instrumentation package, weighing 90 lbs., separates before impact.

A righting mechanism will position the antenna block—a small spherical segment occupying roughly the upper quarter of the total space—where it can radiate a pattern back to earth. Some electronics experts say the "reverse-dish" antenna surface under the balsa layer will radiate a pattern so broad that some error can be tolerated in landing in the designated target area and in righting the inner package.

Such drawings of the capsule as have been published indicate that after the sphere has stopped bouncing and rolling, and the inner package has settled down to an upright position, a puncturing device is actuated. This releases the flotation fluid and "freezes" the instrumentation in a near-erect position relative to the lunar surface.

• **Gentle but tough**—A battery pack at the package midsection forms an annulus around the seismometer. The seismometer is designed to operate for 30 to 60 days. It is expected to provide detection of seismic disturbances due to impact of meteorites on the moon—even if there is no internal lunar seismic activity.

Although the seismograph is so sensitive that it cannot function properly under the l-g acceleration of earth, it is sufficiently rugged to withstand a 1000-ft. drop onto pavement—a peak of 10,000 g's—and still be operable.

Seismometer readings are amplified in the capsule electronics compartment —located, in the present configuration, below the antenna dish and above the instrument. Signals are transmitted through the balsa to earth stations.

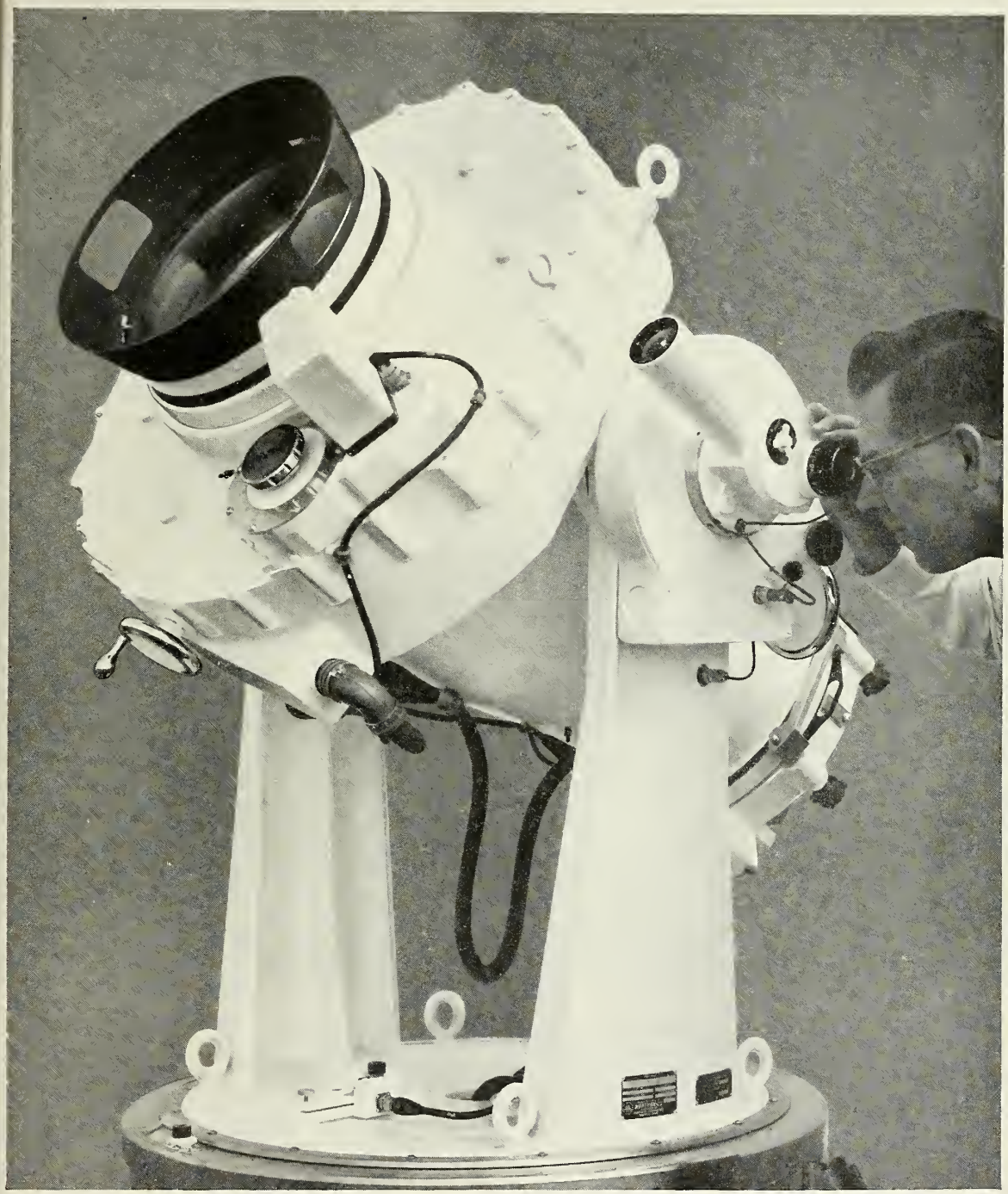
• **Moderating** — Temperature control of the sealed inner package was apparently achieved by two methods.

In one, a relatively thick layer of a cryogenic-type insulation surrounds the package—but not the antenna section. This insulation may be layers of thin foil and foam.

The second method of temperature control uses pure water-filled metal chambers in all voids of the inner package. When internal temperatures increase during lunar "hot" days, the stored water temperature will rise to a pre-set value. Then a thermal control valve will open, permitting hot water to evaporate and thereby lowering the temperature. Water will gradually be lost, but not until capsule lifetime is reached.

During the cold lunar night, heat from electronics plus residual heat in stored water should help to some extent. Latent heat of vaporization released as the water begins to freeze is also helpful in holding the internal temperature above the design maximum limit until solar heat reaches the package.

As in satellite designs, capsule internal temperature can be determined by variations in transmission frequency. This information can only be roughly related to external lunar temperature, but the measurement costs nothing in payload. Temperature readings can validate design assumptions for the *Ranger* temperature control system. ⁂



This camera watches the birdie

This is a ballistic camera, designed to photograph a missile in flight, and check its trajectory against a precise background of stars to detect the slightest deviation from course. It is the largest accurate ballistic camera ever built. Its 8-element, 600-mm, f/2 lens has an accuracy of 1 part in 200,000. Though the shutter is 12 inches in diameter, it opens and closes in 2 milliseconds. The entire instrument, including its unique lens and shutter, was designed and manufactured by Nortronics.

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CREATIVE ELECTRONICS BY RCA



NORAD ON THE ALERT

Inputs from BMEWS Provide Instantaneous Missile Data Direct to NORAD Headquarter

From our vast outer defense perimeter, over thousands of miles, to the nerve center of the North American Air Defense Command at Colorado Springs, the most advanced concept of data handling and checkout is being utilized in the BMEWS system. The stakes are high, for the purpose is defense of the North American Continent.

At BMEWS installations operated by USAF Air Defense Command, computers read out missile tracking data from giant radars. This information is simultaneously relayed to NORAD's Combat Operations Center.

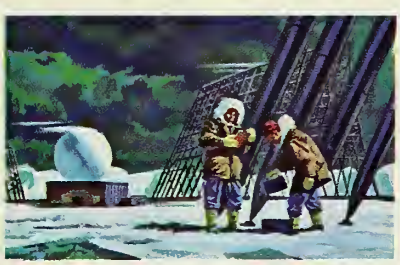
The Radio Corporation of America is prime systems contractor for BMEWS. At the COC, RCA's Display Informatio Processor computing equipment automatically evaluates missi sightings, launch sites and target areas. By means of data pro essing and projection equipment installed by RCA and a team other electronics manufacturers, the findings are displayed huge, two-story high map-screens in coded color symbols, pr viding the NORAD battle staff with an electronic panoram of the North American and Eurasian land masses.

The handling of BMEWS inputs at NORAD is an example how RCA data processing capabilities are assuring the high d gree of reliability so vital to continental defense.





At NORAD Headquarters, RCA computing equipment, the Display Information Processor (control console shown here) receives sightings data from BMEWS and processes it for automatic readout.



RCA is prime system contractor for the sprawling BMEWS three-site radar network whose probing electronic fingers reach deep into space to provide early warning of missile attacks.



RCA's Automatic Checkout & Monitoring equipment continuously tests and checks performance of portions of the system and alerts an operator when a monitored signal exceeds certain limits.

Out of the defense needs of today a new generation of RCA electronic data processing equipments has been born. For tomorrow's needs RCA offers one of the nation's foremost capabilities in research, design, development and production of data processing equipment for space and missile projects. For information on these and other new RCA scientific developments, write Dept. 434, **Defense Electronic Products,** Radio Corporation of America, Camden, N. J.

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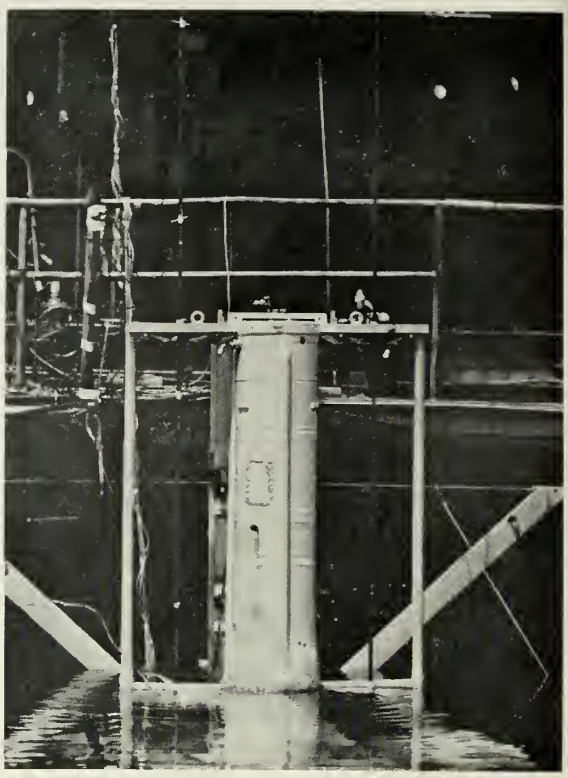
The Most **Trusted** Name in Electronics

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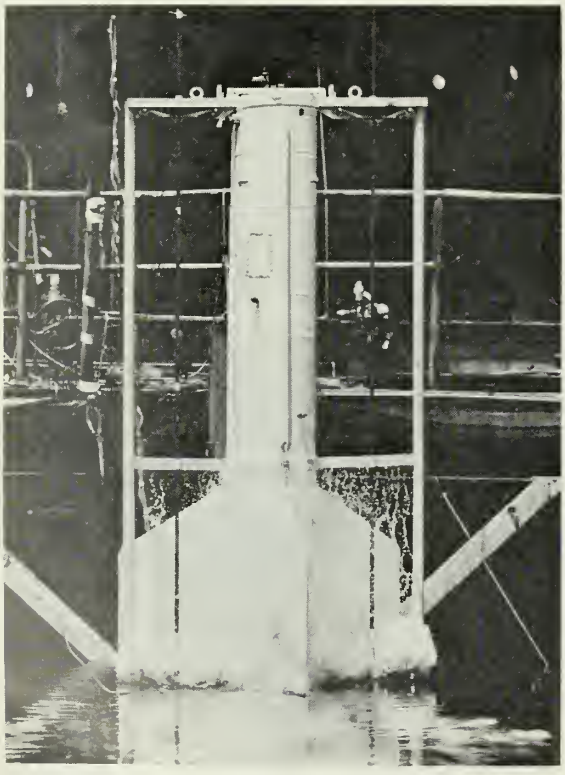
Hydra concept shown . . .

Aerojet Ignites Liquid Sustainer in Underwater Test

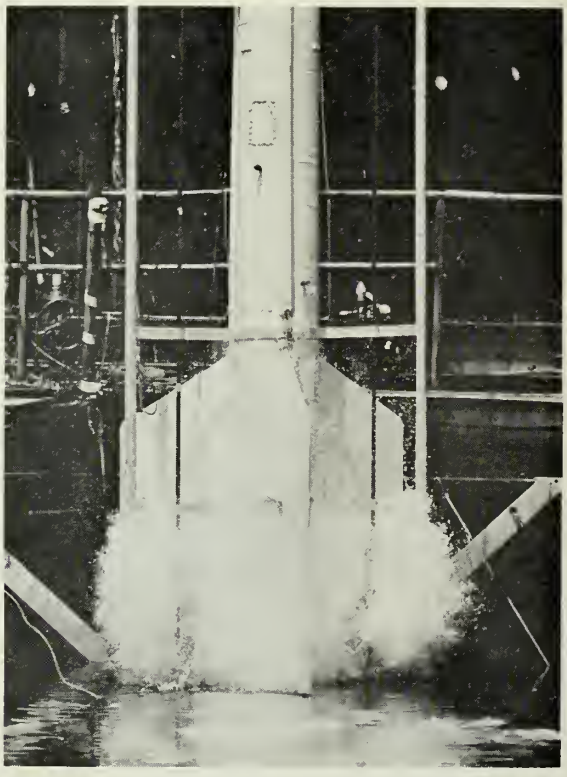
USING a water-filled, 25-ft. deep flame bucket, Aerojet-General engineers earlier this month successfully ignited a liquid-fueled Aerobee Junior sustainer in a captive test underwater. The umbilical connection was at the top of the rocket and out of the water at ignition. In the photo sequence here, the umbilical has dropped away a split-second after firing and the rocket is starting to rise. First the fins, then the whole rocket breaks clear of the water as it rises on 30-ft. shock cables. Aerojet said the test showed the feasibility of underwater launch of liquid-fueled rockets, which is contemplated under the Navy's Project *Hydra* concept. ⁘



1. Umbilical drops (lower left) as Aerobee Jr. fires.

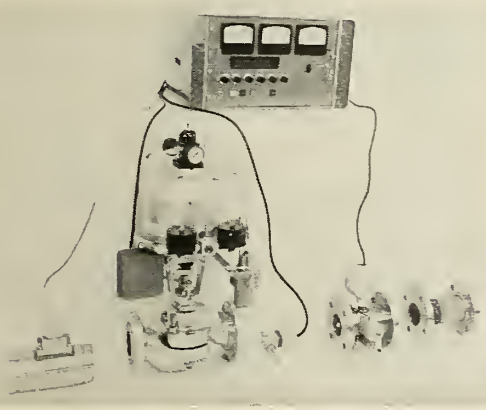


2. Note sealed access door, which was under water.

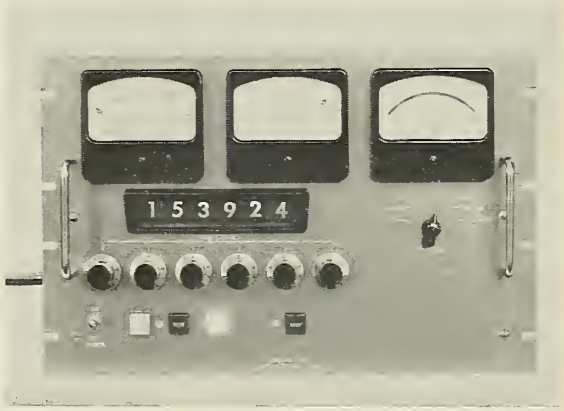


3. Rocket clears water; rising on 30-ft. tether.

Joshua Yields Precise Loading System



COMPONENTS of Potter Pacific's precision propellant loading system are held to minimum consistent with high accuracy.



ELECTRONIC CONTROL unit in Potter system constantly monitors propellant flow. It is checked out before delivery.

by Frank G. McGuire

EDWARDS AFB, CALIF.—Project *Joshua*—the Air Force effort to greatly improve propellants and their utilization in missiles—has brought about a number of new and highly precise systems for handling and loading non-cryogenic and thixotropic fuels and oxidizers.

One precision loading system with accuracies of ±0.05% by weight has been developed by Potter Pacific Corp. It has a minimum number of components, is rugged, flexible, portable and easily serviced in the field, and operates at low cost. The system supplies thousands of gallons of propellant to a missile within minutes, and constantly monitors the flow.

Usable with a wide range of non-cryogenic propellant combinations, the Potter system can be applied to a missile of almost any size, and can handle a number of missiles at a given base.

The system delivered to the Air Force here was specifically designed for use with pentaborane and hydrazine, but can accommodate almost any other combination, as well as the thixotropic —or jellied—propellants now under study and development.

• **Boosting accuracy**—Air Force project engineer H. E. Whitacre and Potter's chief engineer, W. C. Mitchell, said the propellant loading system consists basically of turbine flowmeters and digital counters designed to command valves to close when preset volumes of propellants are delivered to missile tanks.

Aside from this basic makeup of the system, special techniques are employed to enhance the accuracy. The Potter flowmeters can get precision reproducibility of ±0.01% over a narrow range of flow, and advantage has been taken of this by using equipment to control the liquid flow rates to constant values during loading. Flowmeters used for total flow measurement are simultaneously used to sense control rate for control purposes.

Because the flowmeters are volumetric devices, temperatures must be known before mass delivered can be calculated. The system therefore includes accurate multiple-range temperature measurement bridges; charts then tell the operator what correction to introduce into the counter so that a given mass is precisely loaded. Fluids are recirculated through the system and back into the tanks several times in order to equalize temperature so that the average can be determined.

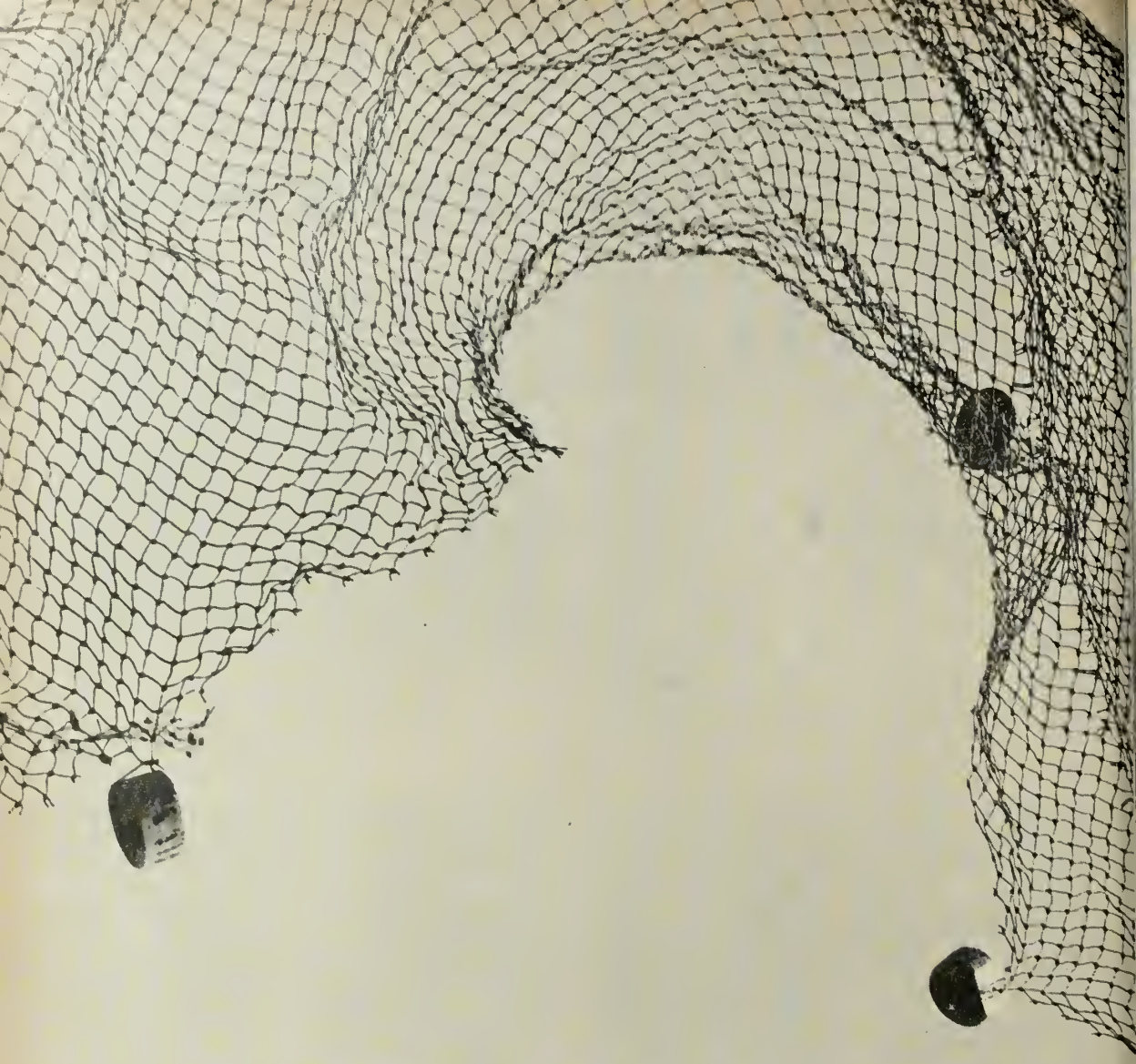
Flow switches are placed in the delivery lines adjacent to the missile, ensuring that the flowmeters do not start measurements until liquid actually enters the missile tanks. This eliminates fluid remaining in the lines from the measurement calculations. Repeatability of valve closing time is enough to maintain system accuracy, and the electronic control unit compensates for liquids which enter the tanks between command signals and full valve closure.

A monitoring function is served by a six-digit readout device showing the count stored in the control unit. Not essential to actual operation of the system, this unit establishes how much flow occurs after the flow control valves receive command signals to close. It also acts as a memory of how much total flow has occurred, in case it becomes necessary to interrupt delivery.

Complete checkout of the electronic control unit and other subsystems is provided for before each delivery. Flow control valves can be opened and the flowmeter braked to provide for gas purging of the plumbing. Most components are of stainless steel, making them compatible with a broad variety of fluids.

• **Key numbers**—Output signals from the flowmeters are sinusoidal, with frequencies proportional to the volumetric flow of the fluid. For *Joshua,* flow rate was set at 400 gpm, with a maximum of 1000 gpm being the upper range of the system.

The output signals have a scale factor on the order of 60 cycles per gallon; the exact meter scale factor must be known in advance in order to determine the numbers to be set into the control unit entry switches. For example, if the volume to be delivered is 2000 gallons, and the meter factor is 60 cycles per gallon, the number to be entered is 120,000. The measured temperature of the liquid modifies this num-



3-nation net into space

oldstone, Calif., Woomera, Australia. Krugersdorp, South Africa. Three different parts of the world thousands of miles from each her. Yet drawn together in a new and unique communications net: e Deep Space Instrumentation Facility.

DSIF is under the technical direction of Cal Tech's Jet Propulsion aboratory for the National Aeronautics and Space Administration. affed and run by the host countries, the tracking stations will have 5-feet-in-diameter antennas, capable of transmitting and receiving. hese giant, revolving steel and aluminum saucers are able to send and ceive signals hundreds of millions of miles to and from space.

It was at Goldstone that JPL bounced signals off the planet Venus— 5-million miles away. This two-month experiment gave us valuable ata about the distance and surface of Venus and helped maintain the nited States as the leader in planetary radar astronomy.

Communicating with deep space probes is just one function of the ree stations of DSIF. Their primary job is tracking all the spacecraft signed by JPL to fly-by, orbit, and land on the moon and planets. Because the stations provide 360° coverage around the earth, one the three will always be in contact with each distant spacecraft flight and after it arrives.

DSIF is an essential participant in the many space projects at JP Ranger, Surveyor, Mariner. Some of these spacecraft are immine Others are on JPL blackboards. All will bring new technologies, n knowledge of our planets and the topless universes beyond, and a s greater understanding of our own small world.

To carry on these vital projects, we need top scientists and engine of many different disciplines. We need people who love their work, w want to know, and want to participate in the exploration of other worl If you believe you're qualified, then come explore with us. Write tod

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• To design and analyze ballistic and ion-propelled trajectories for lunar and interplanetary probes. Must have M. S. in Physics, Astronomy or Engineering Science and two to four years experience in celestial mechanics, trajectories and data analysis.

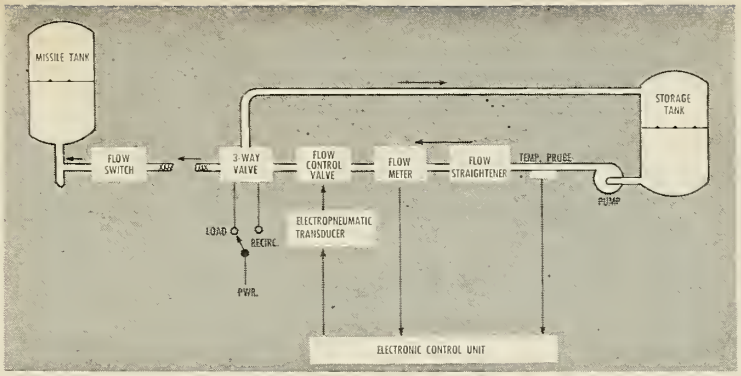
• To study space communications codes for efficiency, error correction, security, reliability, guidance and control. Must have Ph. D. with one year's experience or M. S. with three years' experience in discrete mathematics and applications to information theory, coding problems, and statistical communication theory.

• To study technical and economic feasibility of advanced facilities for vacuum technology, thermal and optical radiation, cryogenic and hydraulic flow systems. Must have at least a B. S. in Mechanical or Electrical Engineering and 6 to 8 years experience (some outside aviation industry) in broad engineering development and/or design.

Other opportunities exist for electronic engineers and physicists in many areas at JPL. Send complete qualification resume now for immediate consideration.

All qualified applicants will receive consideration for employment without regard to race, creed or national origin/U.S. citizenship or current security clearance required.

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FLOW CHART shows how fuel moves from tank to missile.

ber in actual operation, and another alteration is made upon determination of the amount of flow occurring after valve closure signals have been transmitted, but before flow has fully stopped.

Flow straighteners in the system consist of bundles of stainless steel tubing housed in various sections of pipe. These eliminate turbulent and nonlaminar flow, either of which might reduce performance of the flowmeters.

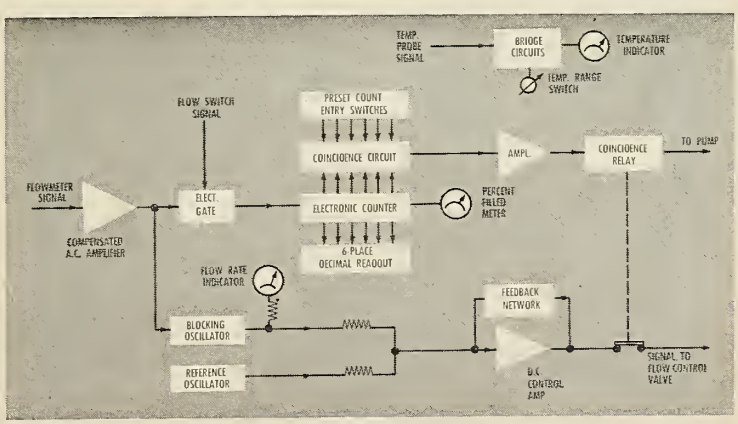
At the missile end of the delivery lines, flow switches are positioned in a housing containing a vane which is used to actuate a miniature switch when flow exceeds a minimum rate. The vane will not be actuated by air rushing through the plumbing ahead of the fluid.

Accuracy for the temperature measuring units is ±0.2°F and measurement response time is in seconds. Reading of the average temperature is made after the electronic control unit is put into its "ready" mode and the pumps have recirculated the fluids through the tanks and system. Six ranges in this equipment cover the spread from zero to 150°F.

After the predetermined cycle count is fed into the entry switches, the mode is changed to "delivery" and flow starts into the missile. A subsystem designed into the setup maintains delivery rates at exactly the desired level—in this case. 400 gpm. Response time of this subsystem is about one second, considered quite adequate for an operation consuming several minutes. Both pressure surges and drops are counteracted by this device.

The "Percent Filled" meter on the face of the electronic control unit is adjustable for any scale of delivery to be made, and the "Flow Rate" meter is calibrated from 0 to 500 gpm.

The equipment is now being modified so that corrections are automatically applied to the preset count, based on temperature, and the recirculation phase of the operation may be eliminated. Another modification will be the inclusion of automatic digital scaling of the flowmeter signal, providing for entry and readout of the propellant amounts in meaningful mass units. Entry dials and readout devices will be calibrated in pounds, thus eliminating the charts presently used for signal translation. ⁘



ELECTRONIC circuitry involved in Potter Pacific system.

Taking Heat out of Solid Case-making

'Ardeform' cryogenic stretch-forming has no size limits, costs less than usual methods

by John F. Judge

A NEW CRYOGENIC metalworking process aimed at solid-rocket motor case fabrication which eliminates dependency on heat-treat furnaces is operational at Arde-Portland, Inc., Paramus, N.J.

Designated Ardeform, the process is essentially a cryogenic stretch-forming method. The basic principle is that cold-working at extremely low temperatures tremendously improves the room-temperature strength of austenitic stainless steels.

• **Roll and weld**—The first step in Ardeforming is the fabrication of the undersized preform. For cylindrical vessels, annealed sheet stock is used as received to make the sections. Inexpensive roll and weld techniques are employed, but high-quality welds must be achieved to permit the considerable amount of stretching that takes place—up to 13% in diameter.

The preform is placed inside a stainless-steel forming die in the steel forming tank. The die is simply a rolled and welded cylinder of specified diameter. The preform is clamped to prevent floating and filled with liquid nitrogen to a level well above that of the preform.

The preform is then filled with liquid nitrogen and sealed off except for a pressurizing line which leads to a supply of compressed nitrogen gas. The outdoor stretching pit is covered with a blast mat. The rest of the operation is controlled from a blockhouse.

When the preform reaches the liquid nitrogen temperature, it is expanded by admitting gaseous nitrogen. A sharp rise in the pressurization rate indicates the preform has reached the die. Final pressure may exceed first contact pressure by as much as 12%.

Pressure is vent-released and the vessel removed from the tank. After being drained it is returned to the plant for final machining.

In the vessels produced to date, Arde has demonstrated nominal tensile strengths of 285,000 psi—equivalent to strength-to-weight ratios of more than 1 million inches.

With suitable design and materials selection, nominal tensile strengths should reach 400,00 psi and strength-to-weight ratios of 1.4 million in., says B. Aleck, research director and developer of the process.

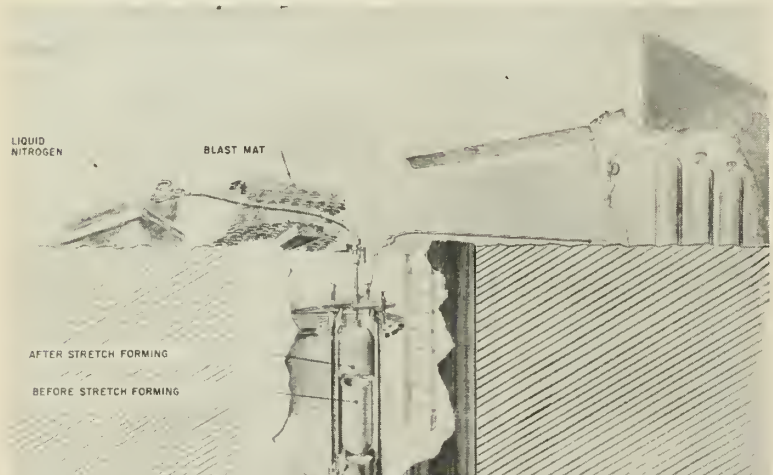
Chambers of 301 stainless have been processed to yield ultimate tensile strengths of 260,000 psi. Most of the operations have been with this material, but the firm has worked with AISI 302 and 304 steels.

Aleck says the process should prove effective with all other austenitic stainless steels. Studies with aluminum and titanium are in a very early stage, but the results look promising.

• **No size limits**—The steel best suited to Ardeforming appears to be 301, because it achieves its maximum strength with a minimum of working. The steels with higher nickel content require more reduction to produce a given strength—but 302 may be preferable where greater local ductility is desired in the preform.

In contrast with conventional motor-case forming methods, Ardeforming has no size limitation. The largest motor cases that can be handled in currently available heat-treating furnaces are approximately 12 ft. in diameter.

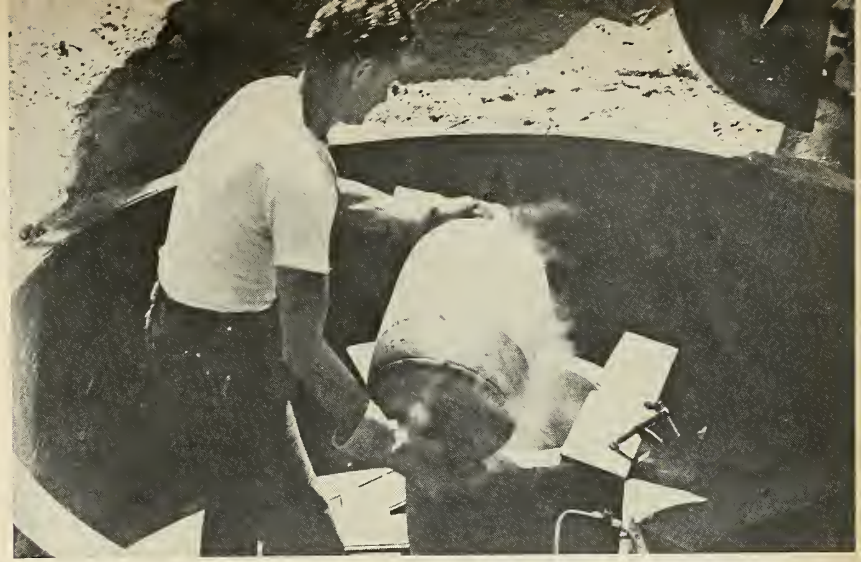
A wide latitude is also permitted in



PILOT FACILITY currently in operation at Arde-Portland's plant in South Portland, Maine. The large outer pit is 12 ft. deep and 10 ft. wide. Preforms fit in the insulated center tank along with the forming die.



CHAMBER AT LEFT is an unstretched 301 preform with a nominal tensile strength of 102,000 psi. The swelled 301 case on its left has been Ardeformed to tensile strength of 260,000 psi. Process has also been used with AISI 302 and 304 steels.



FROST-COVERED CHAMBER is removed from the Ardeforming tank immediately after being stretched. The vessel is still at liquid nitrogen temperatures.

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• • Other Information

end cylinder, the preform must still be a closed container. This involves two extra welding and cutting operations.

Cases have been stretched as much as 22% in diameter. In this instance, the base metal, avoiding this limitation in fabrication. ⌘

Taking Heat out of Solid Case-making

'Ardeform' cryogenic stretch-forming has no size limits, costs less than usual methods

by John F. Judge

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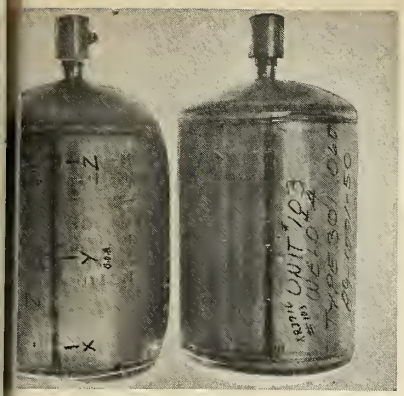
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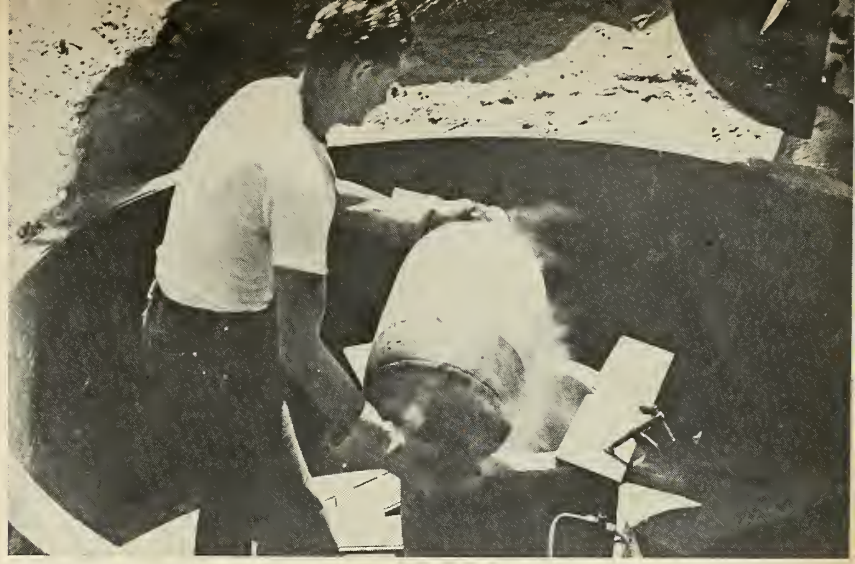
PILOT FACIL... Maine. The large outer pit is 12 ft. deep and 10 ft. wide. Preforms fit in the insulated center tank along with the forming die.

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FROST-COVERED CHAMBER is removed from the Ardeforming tank immediately after being stretched. The vessel is still at liquid nitrogen temperatures.

dimensional control during fabrication of the basic preform. No attempt is made to control out-of-roundness, straightness or diameter dimensions of the preform during welding. All kinks, bends, dents and distortions are removed during the stretching.

Preforms are welded without fixtures, and weld shrinkage occurs without restraint. These conditions result in a crack-free weld with a minimum of residual stresses. Conventional metalworking requires heated, internal-expanding, welding fixtures as well as expensive straightening operations to remove distortions due to heat treating and welding.

The preform needs no intermediate machining and there is less excess stock removal during final machining.

The stretching operation also serves as a proof test of the vessel. Chambers which pass successfully through the stretching operation will also pass the final hydrotest. Among other things, this means a lower scrap loss to the fabricator. Scrapping a vessel immediately after stretching eliminates the costs and times of the usual intermediate operations—straightening, final machining and hydrotesting.

• **Shortcomings** — Ardeforming is not without its drawbacks. More care is required in designing the basic preform. To obtain a finished pressure vessel with spherical heads, the preform heads must, for obvious reasons, be painstakingly designed with regard to material and thickness.

The main disadvantage is the need for dummy heads in the fabrication of open cylinders. To make a simple, open-end cylinder, the preform must still be a closed container. This involves two extra welding and cutting operations. But Arde spokesmen say that the total cost of the processed cylinder is still less than that of a comparable item formed conventionally.

Because the preforms must completely fill the die, certain attachments cannot be welded until after stretching. Welding heat then locally weakens the structure. Arde gets around this by returning the vessel to the forming pit for cryogenic restretching—without a die—but at pressures slightly under the original stretching pressure. This brings the weld strength up to par.

• **Cost playoffs**—The company ran a cost comparison between Ardeforming and conventional methods in the case of an improved motor chamber for an existing air-to-air missile. Lot quantity was pegged at 150. Two comparisons were made.

In the first, a 301 stainless Ardeform case of 240,000 psi yield was matched against a 4130 conventional case, heat-treated to 170,000 psi yield. The Ardeform ran about 15% less in cost.

The second round matched the 240,000 Ardeform chamber with a 240,000 psi D6AC case. The Ardeform came in at a cost figure almost 38% below the vacuum-melted, conventionally formed chamber.

An Ardeform facility capable of 25 chambers per shift would cost under $35,000—an extremely low initial facility pricetag.

In the big booster area, Arde-Portland spokesmen say that a 14-ft.-diameter, 240,000-psi case can be fabricated in 9 separate steps as against the 16 or more that current methods require.

Cases have been stretched as much as 22% in diameter. In this instance, the vessel burst, but experimental chambers have been stretched farther than the 13% case mentioned earlier. Aleck says the amount of stretch is a factor in the strengthening process but there is a leveling-off point at which the room-temperature tensile strength does not greatly increase. This is a characteristic of the material.

Basically, Ardeforming is applicable to any operation involving a die. It is possible to form components with sections of varying thickness. The inclusion of bosses and other attachments to cylindrical pressure vessels is not considered a major problem. End closures with four off-center ports are as easily handled as one with a single centered port. The rate of expansion in the die is not considered critical: it is more a function of the facility. Arde has not experienced any difficulty to date.

The firm is currently fabricating prototype solid-motor chambers, mostly in the small air-to-air category. Helium storage spheres are also being produced. Arde-Portland expects to obtain contracts in both areas, as well as for a large prototype solid-booster case.

Research and development of the process was carried out with company funds bolstered by R&D funds from Army Ordnance and BuWeps. Other potential applications include lightweight, high-strength torpedo cases and ultra-strong tubing of varying cross-sections for weight-critical applications.

The strengthening characteristics of cryogenically working steels are well known, but the main difficulty has been that welding reduced the yield in the weld area by more than 80%. Ardeforming cold-works the welds as well as the base metal, avoiding this limitation in fabrication. ⌘

Foreseeing heavier belts . . .

Astronomers Blast West Ford Go-ahead

Administration's statement fails to convince IAU and others; problem complicated by secrecy shrouding plans

RADIO AND OPTICAL astronomers around the world are protesting President Kennedy's decision permitting the Air Force to proceed with Project *West Ford*—a communication experiment proposed by Lincoln Laboratory of the Massachusetts Institute of Technology.

West Ford—first proposed by Lincoln Lab in the fall of 1959—would place approximately 75 pounds of hair-like, tuned copper dipoles into an undisclosed orbit around the earth to investigate the technical feasibility of using the dipoles as passive reflectors for communications and to assess the effect of this technique on space science or on other branches of science (M/R, Sept. 19, 1960, p. 60).

• **Heavy opposition** — Vehemently opposed to the project are many members of the International Astronomical Union, which wound up its 11th General Assembly Thursday in Berkeley, Calif. During the ten-day session, the IAU's Commission on Radio Astronomy voted unanimously to condemn the project and the Belgian delegation submitted a resolution opposing the experiment for a vote of the assembly.

Four days prior to the IAU meeting, the President's science advisor, Dr. Jerome B. Wiesner, released a policy statement from the National Aeronautics and Space Council in an effort to reassure the scientific community as to the goals of the experiment.

"No further launches of orbiting dipoles will be planned until after the results of the *West Ford* experiment have been analyzed and evaluated," said the statement, which according to Wiesner had been approved by President Kennedy. It also guaranteed that any future experiments of this type would be contingent upon "the development of necessary safeguards against harmful interference with space activities or with any branch of science."

• **Astronomers skeptical** — Prominent members of the Astronomical Union, however, were skeptical of the declaration. They pointed out that although this experiment would probably be harmless the government must intend to exploit any success achieved with future and denser belts—or there would be no reason for conducting the test at all.

Concern was also expressed over the statement that future systems would be contingent on the evaluation of the results of the initial test. This brought up the question of who would make this evaluation and who would make the decision on placing more substantial belts of particles into space.

The decision of the Administration to continue with *West Ford* is based on the military value that such a system may have. Particularly in the Arctic regions, where communications are highly unreliable due to the absorption of radio signals by the dense layer of ionized particles, the system would provide a means of recalling SAC bombers in the event of a false alarm.

• **Classification problem**—Much of the controversy stems from the project's classified nature, which prevents a detailed analysis of the implications of the test. The calculations that astronomers have been able to make have been based on fragmentary information and vague statements about the orbital parameters—such as the illuminating statement that the belt will be "a few thousand kilometers" away from the earth. Even the "appropriate information on a timely basis" concerning the launch date is unavailable to astronomers, in spite of the fact that the Space Council's policy statement calls for the release of such information.

The intense criticism of Project *West Ford,* according to one White House source, is unlikely to materially affect the decision to continue the experiment. However, this official indicated that the project might be in for another Space Council review. ⌘



Minuteman Motor Embarks for Cape

FIRST-STAGE MINUTEMAN engine is loaded aboard C-133 at Hill AFB, Utah (near Thiokol's Brigham City plant), for trip to Canaveral and first "silo" flight test.

—industry—

COLLINS RADIO CO. has integrated all its microwave activities into one organization within its new systems division, the Alpha Corp.

The realignment will unite sales, systems engineering, contract administration, training and customer service. Alpha Corp. was formerly a subsidiary of Collins.

AVIEN, INC. transferred its laser and maser research program from Cambridge, Mass., to the company's corporate R&D dept., Woodside, N.Y. The company has also sold the ownership of its Trident Corp. subsidiary in Cambridge to Maser-Optics, Inc. of Boston.

GENERAL ELECTRIC opened a lab for testing industrial and aircraft true-mass flowmeters at the company's West Lynn, Mass., Instrument Dept.

The new installation will perform experimental and product evaluation tests on all industrial and aircraft liquid mass flowmeters built by the Instrument Dept. Facilities for engineering, research and development of mass flowmeters are located in the new lab.

SHEPHERD INDUSTRIES, INC., Nutley, N.J. has pooled management, manufacturing and sales capabilities with KPT Mfg. Co., Roseland, N.J., and Sinso Electronic Products, Inc., Union, N.J.

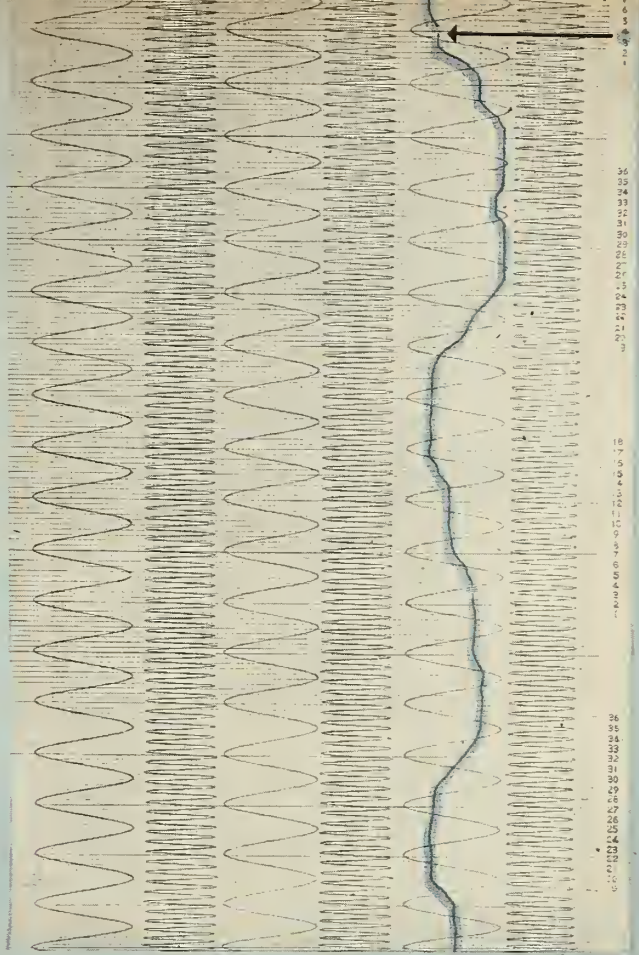
KPT specializes in research, design and manufacture of precision mechanical, electro-mechanical, and hydraulic systems, assemblies and components.

WYLE LABORATORIES established a field engineering office in Huntsville, Ala., to be followed by establishment of a testing lab. Lab operations will begin, Wyle says, when suitable plant facilities can be acquired.

First Huntsville facilities planned by Wyle are standards and calibration labs. These will be followed by environmental simulation facilities, including high-force vibration equipment, and facilities for functional operation of various types of aerospace components and systems.

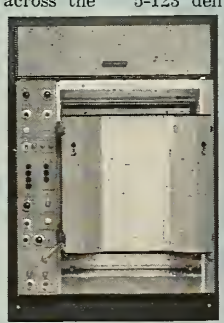
SPACE EQUIPMENT CORP. has been formed in Torrance, Calif., to design, develop and manufacture missile, space and industrial products. Founder and president Edward J. Horkey said the firm will be active initially in electromechanical and electronic ordnance systems and components, and high-strength structures of high-temperature plastics and rubber.

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First Details of Blue Streak Booster



DE HAVILLAND's Blue Streak production line in Hertfordshire.

British are hiking thrust to 300,000 lbs. and plan to test Atlas-like vehicle at Woomera for its space role

IN ANTICIPATION of its use as a European satellite launcher, the British this week reported the first technical details of the *Blue Streak*—including plans to uprate thrust to 300,000 lbs.

The 61.5-ft. *Blue Streak* was proposed as the first stage of an international three-stage satellite launcher capable of putting 2200 lbs. into a 300-mile-high circular polar orbit. A French-built second stage has been proposed, along with a possible hydrogen-oxygen-fueled third stage to increase payload capacity to 3400 lbs. Who will build the third stage has not been determined.

Since its cancellation as an IRBM in April, 1960, the British have continued development of *Blue Streak* on a limited basis and are presently planning R&D flights from Woomera, Australia. Only now, however, have they revealed precise engineering data of the vehicle, which some British engineers claim "is as up-to-date in design as any of its American counterparts."

In many respects the *Blue Streak* resembles the General Dynamics/Astronautics *Atlas*, and this is not surprising. After work was started on the IRBM in 1955, agreements were worked out by de Havilland, the prime contractor, for an exchange of information with G-D/A. Rolls-Royce Ltd., *Blue Streak*, engine developer, made a similar arrangement with the Rocketdyne Division of North American Aviation Inc.

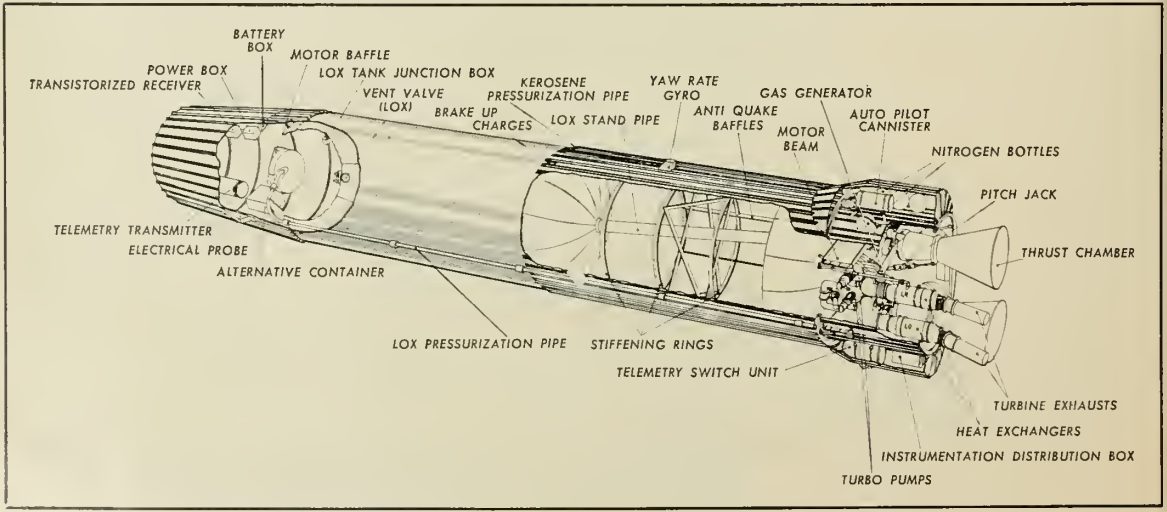
The result was a one-stage vehicle 10 ft. in diameter powered by two gimballed engines, each developing 137,000 lbs. thrust. (They are being uprated to 150,000 lbs. in the space booster.) The tank structure, like *Atlas*, is .019-in.-thick stainless steel with integral LOX and fuel tanks. Launch weight is 92.2 tons and weight at burnout 6.1 tons.

• **Propulsion data**—The two RZ.2 rocket engines are installed as separate units, each with its own propellant feed, combustion and control system. Propellant feed is by turbopump to a regeneratively cooled combustion chamber of tubular-walled construction. Thrust chamber pressure at the injector is 525 psig.

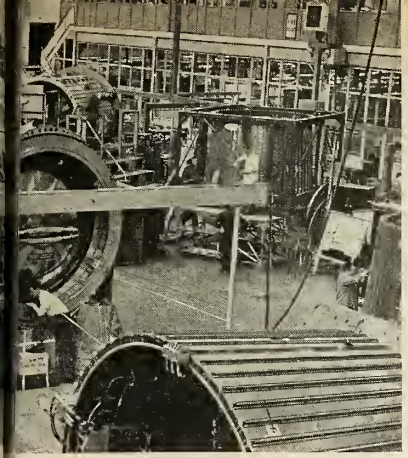
A complete engine weighs 1500 lbs. Together, the two *Blue Streak* engines consume 60.8 tons of LOX and 26.3 tons of kerosene (a fuel mixture of 2.25/1) in a 180 sec. maximum firing.

The LOX system requires a 28.5 psig tank pressurization while working and 4.3 psig while empty. Maximum LOX pump flow is 390 lb./sec. at 785 psig. The pump impeller has a diameter of 11 in.

Working tank pressurization of the kerosene system is 10.25 psig; empty pressure is 1.5 psig. The pump delivers a maximum flow of 170 lb./sec. at 735 psig. The impeller has a diameter of 12.5 in.



CUTAWAY DIAGRAM shows intricate details of Blue Streak, which Britain has proposed for use as the first-stage of a three-stage launcher vehicle for a joint European space satellite program.



A 0.35 oxygen-to-fuel rich mixture is burned in a separate gas generator to drive the pump turbines, which operate off a simple spur reduction gear. Turbine output is 2400 H.P. at 30,000 r.p.m. The pump speed is 6000 r.p.m.

Like the *Atlas*, the vehicle has a ladder-type electro-pneumatic sequential control system for operating various valves during start and shut-down. The system prevents any given operation from taking place until a signal has been received indicating the immediately preceding operation has been completed satisfactorily.

The guidance and control system is hydraulically actuated off of an autopilot. Motor gimballing freedom is 7°, permitting a 0.7° sec. programed turnover rate. Hydraulic H.P. is 3000 psig and hydraulic L.P. 200 psig.

• **Ten R&D flights**—Under the plan advanced earlier this year at the Strasbourg conference for the joint European space program, it was envisioned that the developmental program would cost some $200 million over a five-year period. This would involve 10 firings using the first stage—the last three being attempts at injecting satellites into polar orbit from Woomera.

However, these would be only test satellites designed to determine conditions imposed on them by powered flight and to resolve problems of third-stage separation and residual motion.

No firm plans have been developed for the type of satellites to be launched once the vehicle becomes operational. There is considerable British sentiment, however, in favor of a commercial communications system. One study by Hawker-Siddeley has backed such a system using eight satellites.

No details have been divulged about the specifications for the French-built second stage—outside of a requirement that it increase the 8500 m.p.h. speed of the vehicle at booster burnout to 14,500 m.p.h. and take it to 105 mi. altitude. ⁂

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soviet affairs

By Dr. Albert Parry

Biotelemetry as a space science

is discussed by R. Bayevsky, a candidate of the medical sciences, in a recent article "Biotelemetry and Flight into the Cosmos" in the Moscow daily *Ekonomicheskaya Gazeta*. "Radiotelemetry is the basic means of research in space medicine," he says, "Biotelemetry, its special branch devoted to biological measuring at a distance, has emerged at the crossroads of biology and radiotechnology, and it unites the latest achievements of both these sciences."

The author traces biotelemetry's beginnings to aviation medicine and sports medicine. He divides all biotelemetric systems into two basic categories: dynamic and static. The former allows for free movement of "the object under investigation"; the latter limits movement.

Space flights demand very special

performance from biotelemetry, Bayevsky points out. For space flights, biotelemetric equipment has to be small in size and light, as well as economical of energy. It should work with stability despite the rockets' vibration and acceleration. "The wide application of radiotelemetry in space medicine," he goes on, "compels researchers to pay serious attention to the problem of coordinating the volume of the transmitted information with the capacity of channels of such relay."

Relaying of parameters of muscular bio-currents, for instance, calls for a very wide band of frequencies. On the other hand, a narrow band is needed for body temperature or breath, the transmitting of whose parameters is of comparatively low frequency. Therefore, "the sum total of the capacity of the radiotelemetric tract is proportionate to the width of the band of frequencies and strength of the transmitting equipment."

As space flights progress in distances and duration

they will cause a decrease in the capacity of radiotelemetric channels, since—as Bayevsky explains—"the band of transmitter frequencies will have to be narrowed in order to preserve the strength of the radiotransmitter." And yet the inevitable ramification of space-flight research will lead to "a considerable increase in the number of parameters to be registered." The answer, the author says, is in cybernetics, which science has already created effective methods of programing of various types of data. Channels of small capacity can be utilized, thanks to programing, to increase the contents of information in each signal.

Physiological research methods in space medicine

involving the use of biotelemetry are discussed by Bayevsky under these headings: *Electrocardiography*, to watch the astronaut's heart muscles. *Phonocardiography*, to register the astronaut's heart-tones with the aid of miniature microphones fastened to his chest. *Arterial oscillography*, to measure the astronaut's blood pressure and "the state of his peripheral vessels." *Pneumagraphy*, to test, with spirometric masks and in other ways, the frequency and depth of the astronaut's breathing. *Electromyography*, to register, with electrodes, muscular bio-currents. *Actography*, to measure the degree of the astronaut's (or the dog's, the rat's, etc.) physical activity (movement) while in flight, with such counters as tensormetric, contact, piezoelectric, etc.

Modern electronics can now implement

an idea which, Bayevsky says, until recently "has seemed fantastic—to build a multiple-channel radiotelemetric transmitter no bigger than a pocket cigarette-case." This, he implies, has tremendous bearing on further progress of Space-Age biotelemetry.

He mentions the American success in creating a miniature transmitter that can be placed on the back of a mouse. It is true, Bayevsky adds, that this equipment can transmit over a very small distance only —no more than a score or two centimeters, but both American and Soviet scientists continue to work on the improvement of such miniaturization to increase effectiveness over greater distances.

letters

(Continued from page 6)

and fiscal employees. Thus, our recruitment "publicity" has been doing the job intended and not whatever devious tasks hinted at by Mr. Burns.

Mr. Burns should be grateful that MISSILES AND ROCKETS is willing to treat controversial issues fairly. The role of organizations engaged in the struggle to combine technological leadership and deterrent strength within a framework of cost/time/effectiveness needs all the clarification responsible editors can provide.

L. R. Allen, Jr.
The MITRE Corporation
Bedford, Mass.

Recover the Capsule

To the Editor:

Our second space shot with Capt. Grissom on board certainly has been a great accomplishment. However, its value with respect to world-wide recognition has been badly influenced by loss of the space capsule. Despite many voices declaring that the loss is of only minor technical significance, the fact remains: we lost it.

As I see it, and everyone I have talked to so far agrees with me, the recovery of this capsule could be worked into an enormous propaganda victory.

All reports I have heard agreed unanimously that the capsule cannot be recovered. This I can't see at all—on our series of tests using the Bathyscaph owned by our Navy, we have proven that we can reach the deepest spot of any ocean and certainly a depth of 18,000 feet.

I believe that every true American would be proud to spend a few pennies or, if necessary, a couple of dollars each to contribute to another "American first."

We have established that we have the equipment and that we can get the necessary money. As for engineering problems, I am sure we can master them.

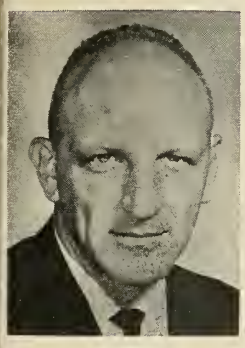
The technical details may be summed up as follows:

1. Establish exact location where the capsule was dropped.
2. Drop a similar capsule (may be one of the prototypes) from this spot and follow it with sonars and metal detectors all the way down. In all probability, it will land near Grissom's unit. Search for *Liberty Bell 7*.
3. Conduct a thorough search of the ocean bottom and the ocean currents for establishing the best salvage methods with the Bathyscaph, if necessary.
4. Modify, where necessary, the Bathyscaph and equip it with suitable salvage mechanisms. The blimp already has some electro-mechanical devices on board for navigation and dropping of its ballast.
5. Salvage the capsule—and play it up big in the press.

L. R. Siegl
Senior Project Engineer
The Hartman Electrical Mfg. Co.
Mansfield, Ohio

P.S. It would be very disappointing if the Russians recovered it before we did.

names in the news



FIQUETT



HOPPER



RYDEN

Cecil Fiquett: Former reliability and quality engineer, *Saturn* Project Office at NASA's George C. Marshall Space Flight Center, named to head Wyle Laboratories' new field engineering office in Huntsville.

Robert W. Kluge: Named director, Special Defense Program; **Sidney Stark,** director, Advanced Systems; and **Herman R. Staudt,** director, *Pershing* Ballistic Missile System Program, The Martin Company's Orlando Division, Fla.

Dr. N. L. Krisberg (USAF-ret.): Former vice commander of the Air Force Office of Aerospace Research, joins The Boeing Co.'s Aero-Space Division as assistant chief of technical staff.

Dr. Grace L. Hopper: Appointed director of systems research for Remington Rand Division, Sperry Rand Corp., New York City. With the company's Univac Division since 1950, Dr. Hopper is a nationally-known mathematician and is the originator of electronic computer automatic programing.

Dr. Isidore Hodes: Former consultant to Bendix Corp., appointed head of Plasma Physics Laboratory for the Aero/Space Dept., General Motors Defense Systems Division, Santa Barbara, Calif. Assisting Dr. Hodes is **Arthur A. Vuylsteke,** formerly of GM Research Laboratories Physics Dept.

John W. O'Hara: Former manager of Systems Engineering Div., Minneapolis-Honeywell Co., named to head the Industrial Electronics Dept., Systems Engineering Div., Aero Service Corp., Philadelphia.

Dr. Lester C. Van Atta: Appointed technical director, Hughes Aircraft Co.'s research laboratories, Malibu, Calif. While on leave from Hughes, Dr. Van Atta recently completed a year's service in Washington, D.C., as special assistant for arms control for the Director of Defense Research and Engineering in the Office of the Secretary of Defense.

Dr. M. John Rice, Jr.: Appointed director of engineering for Semiconductor Operations, CBS Electronics, manufacturing division of Columbia Broadcasting System, Inc., Danvers, Mass. Previously Dr. Rice was manager of semiconductor material engineering.

Brig. Gen. Bernard M. Wootton (USAF-ret.): Veteran of 30 yrs. service and former Commander of the Pacific AACS Area, joins Page Communications Engineers, Inc., Washington, D.C., as executive director of contract services.

Harry M. Sisson: Named director of administration; **Kenneth Bank,** division counsel; and **J. J. Hanrahan,** personnel and labor relations manager, for the Organics Division, Olin Mathieson Chemical Corp., New York City.

Jack W. Blanchard: Appointed chief engineer, Phoenix Electronics plant, Kaiser Aircraft & Electronics Div., Kaiser Industries Corp. Prior to joining Kaiser, Blanchard was senior project director and associate research engineer, University of Arizona, Tucson.

Roy A. Olerud and **William B. Croxville:** Named general managers of Industrial Electronics Division and Electronic Tube Division, respectively, Allen B. Du Mont Laboratories, Divisions of Fairchild Camera and Instrument Corp., Clifton, N.J. Olerud rejoins Du Mont from International Telephone and Telegraph Corp.; Croxville formerly was with Sperry Rand Corp.

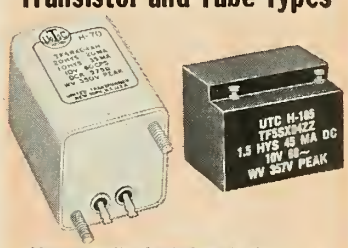
Dr. Lorraine S. Gall: Named a specialist microbiologist in the Space Environment and Life Sciences Laboratory of Republic Aviation Corp.'s Research and Development Center, Farmingdale, N.Y. **H. C. Towle** appointed manager of the company's newly formed Systems Integration Section.

Arnold J. Ryden: Appointed to board of directors, Avien, Inc., Woodside, N.Y., filling the vacancy caused by the resignation of **William O. Boschen.** Ryden also is president of Midwest Technical Development Corp. and Telex, Inc., Minneapolis, and chairman of the boards of National Semiconductor Corp., Danbury, Conn., and International Properties, Inc., Minneapolis.

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—contracts—

NASA

$3,224,183—**International Business Machines Corp.**, Huntsville, Ala., for rental of electronic machines to compute administrative and scientific data for the *Saturn* space vehicle project (2 contracts).

$2,000,000—**Ryan Electronics**, San Diego, from **Hughes Aircraft Co.**, for design, development, and fabrication of radar altimeter and Doppler velocity sensor equipments for NASA's *Surveyor* lunar soft-landing vehicle.

$1,000,000 — **Radiation Incorporated**, Melbourne, Fla., for PCM telemetry ground equipment for the *Nimbus* weather satellite.

$993,559—**Radio Corp. of America**, Princeton, N. J., for development of a payload capsule for electrical propulsion system flight-testing.

$846,500—**Flexonics Corp.**, Bartlett, Ill., from Marshall SFC, for design, fabrication and testing of vent, pressurizing and propellant feed lines on the *Saturn's* fuel and liquid oxygen system.

$450,000—**Ryan Electronics**, San Diego, for development and fabrication of high-altitude radar altimeters for the *Saturn* space vehicle.

$114,128—**Space Technology Laboratories, Inc.**, Los Angeles, from Marshall SFC, for a study of the payload-carrying capabilities of current U. S. medium-class space vehicles, with respect to future satellites and mission requirements.

$98,264—**General Dynamics/Convair**, San Diego, for research on feasibility of using a magnetohydrodynamic (MHD) engine to propel vehicles through deep space.

$52,000—**The Martin Co.**, Baltimore, from Goddard SFC, for study of effects of extended space missions on non-metallic materials.

MISCELLANEOUS

$547,984—**Elgin National Watch Co.**, Elgin, Ill., for production of safety and arming devices used in *Sidewinder, Sparrow* and *Hawk* missiles.

$427,000—**Gulton Industries, Inc.**, Metuchen, N. J., from **Grumman Aircraft Engineering Corp.**, for power storage and conversion systems for the *Orbiting Astronomical Observatory* (*OAO*) satellite program.

$321,000—**American Orbitronics Corp.**, Hawthorne, Calif., from **Aerojet-General Corp.**, for missile components.

$767,000—**Continental Electronics Mfg. Co.**, Dallas, subsidiary of **Ling-Temco Electronics, Inc.**, for BMEWS radar transmitter equipment.

$100,000—**Industrial Electronics Dept., Westinghouse Electric Corp.**, Baltimore, for five 15-KW, dual-frequency RF generators for **North American Aviation Corp.**

Radiation Incorporated, Melbourne, Fla., from **Bell Telephone Laboratories**, for development, fabrication and installation of two automatic-tracking antenna systems for use with Bell System's experimental communications satellite. No amount disclosed.

Lockheed Aircraft Service, Ontario, Calif., from **MacDonald-Scott and Associates**, for testing and calibration of propellant-loading systems at nine *Titan* missile launch sites near Moses Lake, Wash.

NAVY

$1,800,000—**Hughes Aircraft Co.**, Culver City, Calif., from BuWeps, for production of a new infrared device to measure small changes in temperature.

$1,000,000—**Microwave Associates, Inc.**, Burlington, Mass., from BuWeps, for production of magnetron tubes.

$63,000—**Daystrom, Inc., Pacific Div.**, Los Angeles, for control gyroscopes and spares provisioning data for *Regulus I* missile.

Circle No. 14 on Subscriber Service Card

Hughes Aircraft Co., Fullerton, Calif., for studies into the feasibility of integrating all communications, weapons, sensors, and command and control systems aboard a nuclear attack-killer submarine and a guided missile frigate to be built in '62-'63. No amount disclosed.

Radio Corp. of America, Burlington, Mass., for research and development of an autopilot system design for hydrofoil craft. No amount disclosed.

McCormick Selph Associates, Hollister, Calif., from Naval Air Development Center, for development of a miniaturized gas generator to inflate sonobuoy flotation bags. No amount disclosed.

ARMY

$70,685,283—**The Martin Co.**, Orlando, Fla., for *Pershing* weapon system (2 contracts).

$16,998,127—**The Martin Co.**, Baltimore, for design, construction and test operation of a 10000 KWe (net) floating nuclear power plant.

$4,031,455—**Raytheon Co.**, Waltham, Mass., for concurrent repair parts for the *Hawk* missile system; $113,330 for *Blue Streak* and emergency replenishment parts.

$357,103—**Sperry Gyroscope Co.**, Great Neck, N. Y., for field engineering services in support of *Sergeant* missile system.

AIR FORCE

$5,440,000—**Sperry Gyroscope Co.**, Great Neck, N. Y., for installation and testing of high-powered, long-range, frequency-diversity search radars.

$2,100,000—**Reconnaissance Systems Laboratories, Sylvania Electronic Products, Inc.**, Mountain View, Calif., for engineering and production of receiving equipment.

$2,000,000 — **Minneapolis-Honeywell's Boston division, from General Dynamics/Astronautics**, for rate gyroscopes for use in guidance systems on *Atlas* missiles.

$1,917,000—**RCA's West Coast Missile and Surface Radar Division**, Van Nuys, Calif., from **GD/Astronautics**, for *Atlas* missile launch control and checkout equipment (2 contracts).

$1,700,000—**Franklin Institute**, Philadelphia, for design, development, and construction of dynamic escape simulator for use in designing escape capsules for high-speed jet aircraft and *Dyna-Soar*.

$1,014,548—**The Martin Co.**, Baltimore, for repair and modification of *TM61/76A* missiles and related equipment.

$255,000—**Brush Beryllium Co.**, Cleveland, for continuation of development of production techniques for aircraft-quality beryllium sheet.

$250,000—**National Research Corp.**, Cambridge, Mass., for research and development on encapsulated ingredients for solid propellants.

$145,000 — **Space-General Corp.**, Glendale, Calif., for research into the feasibility of detecting underground nuclear explosions by means of electromagnetic signals.

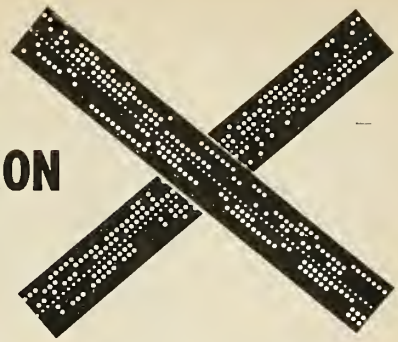
$76,000—**Melpar**, Falls Church, Va., for continued investigation of electronic neurons for flight control and other systems pertaining to satellite reliability and control.

$73,056—**Armour Research Foundation, Illinois Institute of Technology**, Chicago, for research on analytical investigation of combustion instability in solid-propellant rockets.

Space Technology Laboratories, Los Angeles, from AFSC, for a study of the effects of highly accelerated microscopic particles striking various surfaces. No amount disclosed.

Automation Industries, Inc., Manhattan Beach, Calif., for investigation of the use of infrared energy in evaluating critical aircraft and missile materials.

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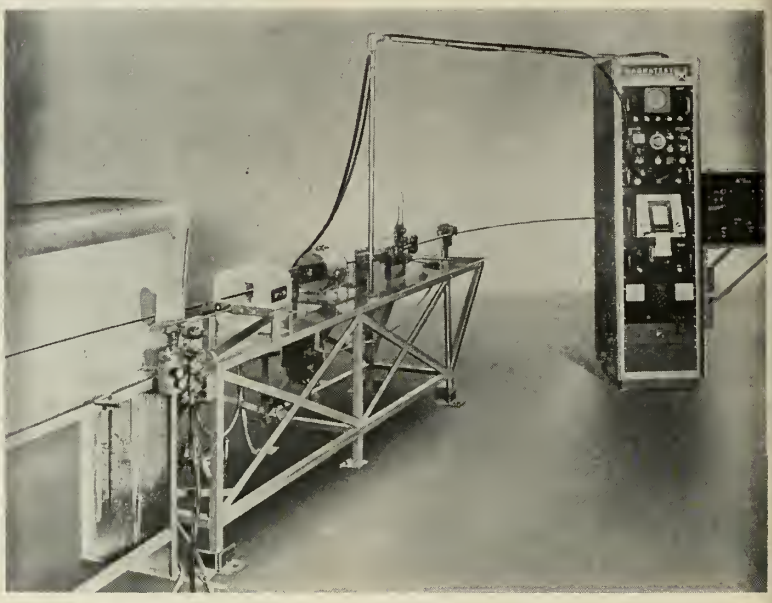
Ships, planes, and submarines to simulate combat maneuvers on battle terrain were required for a naval classroom training device. The problem was taken to Kollmorgen . . . and solved with a unique projector system that can produce up to 36 individual silhouettes of military warfare equipment—fully controllable at any speed, in any direction, and on any screen or wall. Depending upon design parameters, as many as 144 images or more could be provided.

The multi-image projector operates by utilizing a variable number of image projectors to cast preselected images on a screen. A separate projector system provides stationary grids or charts. Thus, images can be maneuvered on simulated battle environments by remote control.

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Detector Finds Spring Flaws

Associated Spring Corp. is applying continuous high-speed electronic flaw inspection of ferromagnetic spring wire on a production basis. The system, using a specially adapted eddy-current detection technique, greatly improves the quality and reliability of high-performance springs.

Development of this production tool allows the elimination of any wire with harmful nicks, pits, and seams that may cause expensive spring failures in service. The test equipment uses a combination of electronic and mechanical systems. The electronic circuitry provides the signals for a tape readout which designates "off-specification" sections of the wire tested. Sections of wire failing to meet set standards are marked by a lacquer spray for subsequent discard.

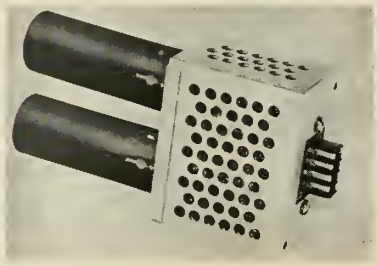
The tape becomes a permanent record that can serve to certify wire quality. An eddy current is induced in the wire by means of exciter coils. A pair of sensing coils detects any change in the normal eddy-current pattern of sound wire if the pattern is interrupted by flaws, such as pits, seams or scratches. The electronic equipment amplifies and filters these changes and then triggers the marking system. The equipment will initially be used primarily for the inspection of valve-spring quality wire. The unit also may be used to inspect other wire for springs requiring a great degree of reliability.

Circle No. 225 on Subscriber Service Card

Booster Follower

A new plug-in follower amplifier, Model K2-BJ to be used as a booster with militarized operational amplifiers has been announced by Philbrick Researches, Inc. A rugged militarized version of the earlier K2-B1, the new improved K2-BJ provides for the operational amplifiers an increased steady-state output of 20 ma at ±100 volts, gain about 0.8, output impedance about 250 ohm (before feedback).

Circle No. 226 on Subscriber Service Card



Rotary Generator

Pacific Scientific Instrument Laboratories is marketing a rotary acceleration generator designed for test qualification programs and production testing. The 20-in.-diameter spin table, designated model RA-ATC-500-1, tests dynamic characteristics of instruments and scientific objects from 3 to 500 g-pounds. Among these are accelerometers and

Circle No. 16 on Subscriber Service Card

transducers, small flight packages and other instruments requiring high g qualification. A large number of ¼-in. tapped holes are arranged at increasing radii starting at 3 in. and going up to 9 in.; these are provided for securing test objects and fixtures. The rotary acceleration generator employs dual controls to provide an infinite variable platform speed within an operating range of from 10 to 2000 RPM.

Circle No. 227 on Subscriber Service Card

Linear Accelerometer

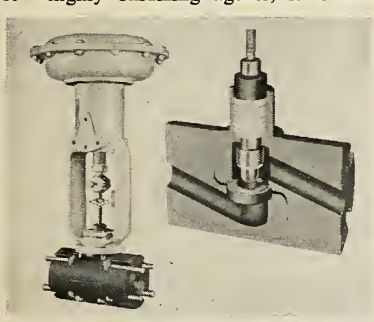
A miniature piezoelectric linear accelerometer that features high natural frequency characteristics, small size, and rugged construction has been introduced by Statham Instruments, Inc. The Statham Model AK 105 employs a sensitive, self-energizing piezoelectric element for reliable and accurate measurements of linear accelerations.

Designed to withstand aerospace environmental requirements, the Model AK 105 is encased in stainless steel and operates over a temperature range of −65°F to 250°F. Other characteristics of the accelerometer are: natural frequency, approximately 50 kc; sensitivity, nominal 17 peak millivolts per peak g at room temperature; weight, approximately 0.8 ounces.

Circle No. 228 on Subscriber Service Card

Graphite Control Valve

Designed especially for corrosive service, or where thermal shock is a factor, this single-seated control valve utilizes impervious graphite in the split-body construction. Impervious graphite is unaffected by all corrosives except a few highly oxidizing agents, it is immune to the effects of thermal shock and is non-contaminating to material in process. The valve is a product of Falls Industries, Inc.



Circle No. 229 on Subscriber Service Card

Cable Connector Kit

A designer's kit that provides design flexibility in the use of ribbon cable and includes the necessary items to fabricate special ribbon cable assemblies has been announced by Digital Sensors Inc. The connectors are the new Tape-Terms



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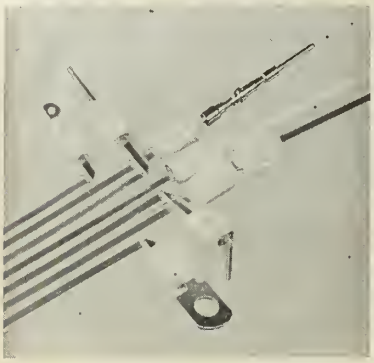
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which are supplied in a variety of models for use in terminating or connecting ribbon cable to almost any type of electrical connection, including wire type connectors.

The Tape-Terms require no stripping of the conductors and are installed with a crimping tool provided in the kit. The kit also includes a five-foot-length of ten conductor ribbon cable, complete instructions on how to best apply ribbon cables and information on its characteristics.

Circle No. 230 on Subscriber Service Card

Versatile Cone Drill

Lower tool costs, fewer tool changes, and elimination of separate finishing steps in some drilling operations are made possible by a new cone drill developed by Scully-Jones and Co. A single drill produces a wide variety of hole diameters in metal, plastic, or any other relatively thin material. Tool change time and need for stocking a variety of drill sizes are eliminated. It drills any hole size from ¼" to 1¼". The cone drill eliminates circular hack sawing or knockout punching in sheet metal work. It has a 7/32-in.-diameter drill point, so no center drilling or punching is necessary.

Circle No. 231 on Subscriber Service Card

Radiation Test Set

A complete radiometric measuring system designed to test or evaluate optical systems, detectors or detector electronics, and to determine the effects of changes in configuration has been developed by Barnes Engineering Co. Also when used in conjunction with a known intensity radiation reference source, the test set can be used to obtain absolute values of the parameters for portions of radiometric systems. Values of monochromator resolution, optical filter transmission, optical system collecting power, detector responsivity, and in addition, relative values of many other parameters can be obtained.

Circle No. 232 on Subscriber Service Card

Analog Multiplier

Static accuracy of .15%, simplified circuit design, and reduced cost are features of the electronic multipliers, Model 160, from Applied Dynamics Inc. The multipliers are available on the firm's analog computers as separate components for expansion of other dc analog systems operating between ±100 volts as independent units or as individual boards.

Absolute value circuits permit reduction of the number of components, increasing reliability, and lowering cost of the multipliers, which can be used for multiplication, division, squaring, or extracting square roots. The solid-state units are temperature compensated, with bandwidth limited primarily by amplifier operation.

Circle No. 233 on Subscriber Service Card

Hall Devices

Two new Hall-Effect magnetic sensing devices—the Transverse Field and Axial Field "Hall-Paks"—have been produced by F. W. Bell, Inc. Both units are of non-inductive construction, making possible new and improved dc applications. They exhibit low noise output, improved low-level performance, and high Hall output combined with low zero-field output voltage to eliminate the need for external null voltage compensation in many applications. Both the axial and transverse "Hall-Paks" operate in the broad temperature range of —40°C to 100°C and are designed for continuous operation at 85°C.

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Circular Metal Seal

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developed by research engineers of Lockheed-California Co., a division of Lockheed Aircraft Corp. E. B. Wiggins Oil Tool Co., which collaborated with Lockheed in product development, is manufacturing and marketing the BAR -X- seal under terms of a licensing agreement. Laboratory tests show the cruciform-profile seals remain effective at temperatures from −400 to 1500 °F, and at pressures from spatial vacuum to 600 lbs. per square inch.

Circle No. 235 on Subscriber Service Card

Ferrite Isolators

Sylvania Electric Products Inc. is marketing magnetically shielded ferrite isolators for operation from 1.0 gc to 11.0 gc. Designed for use in compact systems where component space is



severely limited, the isolators function in close contact with other magnetic materials with no degradation of performance or adverse effect on adjacent circuitry. They offer 10 to 1 isolation-to-insertion-loss ratios with maximum VSWR's of 1.3 to 1. Typical bandwidths are 1.36-2.56 gc, 4.2-6.0 gc, and 4.8-7.0 gc. All performance characteristics are maintained from −30 to 60°C. The units can be fitted with any standard coaxial connector.

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EBW Checkout Unit

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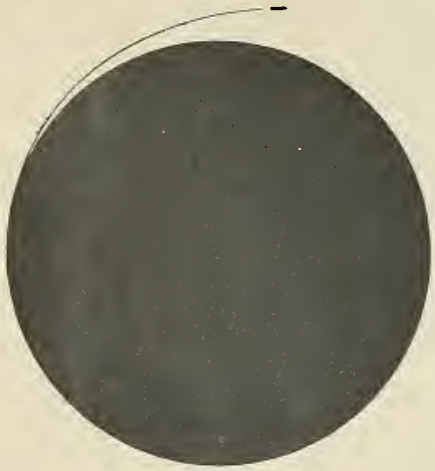
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PROPELLANT SYSTEM	SPECIFIC IMPULSE	
	Sea Level 1000→14.7	Space 1000→0.2
H_2–O_2	391	470
B_5H_9–OF_2	367	466
B_5H_9–F_2	360	460
N_2H_4–F_2	363	436
B_5H_9–O_2	327	421
B_5H_9–NF_3	326	412
B_5H_9–H_2O_2	316	405
B_5H_9–N_2O_4	306	391
B_5H_9–ClO_3F	306	390
RP–O_2	300	379
B_5H_9–ClF_3	290	368
N_2H_4–N_2O_4	291	354
CH_2–NO_2ClO_4	278	349

*Available upon letterhead request from:

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West Coast: 15537 Lanark Street, Van Nuys, California, Telephone STate 1-5761
Washington, D.C.: 709 DuPont Circle Building, Telephone ADams 4-4200
Dayton, Ohio, Suite 12, 2600 Far Hills Avenue, Telephone AXminster 8-1242

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reviews

MAN'S VIEW OF THE UNIVERSE, R. A. Lyttleton, Atlantic-Little, Brown, Boston, 108 pp., $3.95.

The author has used his hundred-odd-pages well by giving to the lay reader a lucid and seemingly unhurried description of our universe. This is a difficult thing to do—to discuss the earth in only nine pages, the planetary system in the same space, and the sun in only eight pages. Yet, in a style far more literary than telegraphic (although the latter might seem the style to use in a space so cramped), Lyttleton even manages to discuss some of the intricacies of recent astronomical investigations and to indicate some of the problems to be solved. This book is probably the easiest way for an adult to make his first step into astronomy.

METEOR SCIENCE AND ENGINEERING, D. W. R. McKinley, McGraw-Hill Book Co., New York, 309 pp., $12.50.

This is a book for the engineer who, either through curiosity or because of his job, wants to know something about the properties, behavior and effects of meteors and the means available for watching them.

The meteor expert looking for field and laboratories studies of meteorites will not find them here. Instead, he will find a good attempt at unifying the field of meteor science and engineering—first, by a survey of the visual and photographic techniques for watching meteors; next, by a technical but not overpowering discussion of radio techniques for keeping track of meteors; and finally, after going into astronomical aspects and some physical theory, by an easy-to-read study of the practical applications of the forward-scattering properties of meteors to commercial and military communications systems.

The author is well qualified to write the book, having published more than 40 scientific papers on radio observations of meteors in addition to other papers on radar design and electronic design. He is presently Associate Director of the Radio and Electrical Engineering division of Canada's National Research Council.

THE PHYSICAL PRINCIPLES OF ASTRONAUTICS, Arthur I. Berman, John Wiley and Sons, Inc., New York, 350 pp., $9.25.

The alternate title is "Fundamentals of dynamical astronomy and space flight," which is more descriptive because Astronautics, like Aeronautics, embraces the spectrum from vehicle design to modern physics.

What the author seems to be showing is the effects of the astronomical bodies and Newton's and Kepler's laws on space vehicles. He does this simply and well, so well that an engineer would find reading the book enjoyable as well as rewarding.

The text is written for late-undergraduate or early-graduate level, and for students whose calculus may be dusty but not tarnished. The author writes from fundamental principles and doesn't stray far from them. Most readers can add their own flourishes if they want to.

In Part I, semiquantitative aspects of the astronomy of the solar system are treated. Part II discusses those fundamental concepts of mechanics needed for an understanding of astronautics—mass, weight, potential energy, and Coriolis force. In Part III, the properties of orbits and transfer trajectories and the effect of perturbative forces are described.

In effect, the book is a starting point for the technical man going into astronautics. It is highly recommended.

TRANSISTOR CIRCUIT ANALYSIS, Maurice V. Joyce and Kenneth K. Clarke, Addison-Wesley Publishing Co., Reading, Mass., 461 pp., $10.75.

Here is a text for the serious student and worker in junction transistor circuitry. It presumes that the reader has a reasonable background in transient analysis techniques, in the use of pole-zero patterns in network analysis, and in logarithmic gain and phase plots. Given this background, the student will proceed easily through the basic methods of analysis given early in the book.

The authors emphasize that this is not a text in solid-state physics or transistor construction, nor is it just a compilation of a large number of transistor circuits. The transistor models employed in the book are restricted to a small number that are all easily interrelated.

Initially, simple low-frequency models are presented and are related to the underlying physical processes that occur in the devices. Then, after the reader has been made familiar with the simple models, the text introduces complications.

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AUGUST

American Society of Mechanical Engineers 1961 West Coast Conference of Applied Mechanics, University of Washington, Seattle, Aug. 28-30.

ASME and AIChE International Heat Transfer Conference, New Developments in Theory and Practice, University of Colorado, Boulder, Aug. 28-Sept. 1.

Third International Symposium on Rockets and Astronautics, Japanese Rocket Society, Tokyo, Aug. 28-Sept. 1.

Second Annual Bionics Symposium, sponsored by General Electric Co. and Cornell University, GE Advanced Electronics Center, Ithaca (N.Y.), Aug. 30-Sept. 1.

SEPTEMBER

Army Aviation Association of America Annual Meeting, Sheraton-Park Hotel, Washington, D.C., Sept. 3-5.

Farnborough Exhibition, England, Sept. 4-10.

8th Anglo-American Aeronautical Conference, Royal Aeronautical Society and Institute of the Aerospace Sciences, London, Sept. 4-14.

National Conference, Institute of Engineering Inspection and Society of Non-Destructive Examination, Oxford, England, Sept. 5-8.

Joint Nuclear Instrumentation Symposium, sponsored by IRE's professional groups on Nuclear Science and Instrumentation, AIEE, ISA, and others, North Carolina State College, Raleigh, Sept. 6-8.

National Symposium on Space Electronics and Telemetry, IRE, University of New Mexico, Albuquerque, Sept. 6-8.

National Conference, Association for Computing Machinery, Statler-Hilton Hotel, Los Angeles, Sept. 6-8.

1961 New Product Exhibit and Conference, Los Angeles Chamber of Commerce, Ambassador Hotel, Sept. 7-8.

1961 Fall Meeting of the Combustion Institute, Western States Section, University of California, Berkeley, Sept. 7-8.

Electronics Engineers Wanted for M/R Editorial Positions

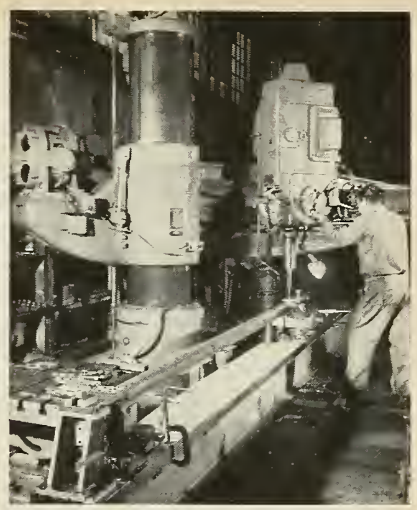
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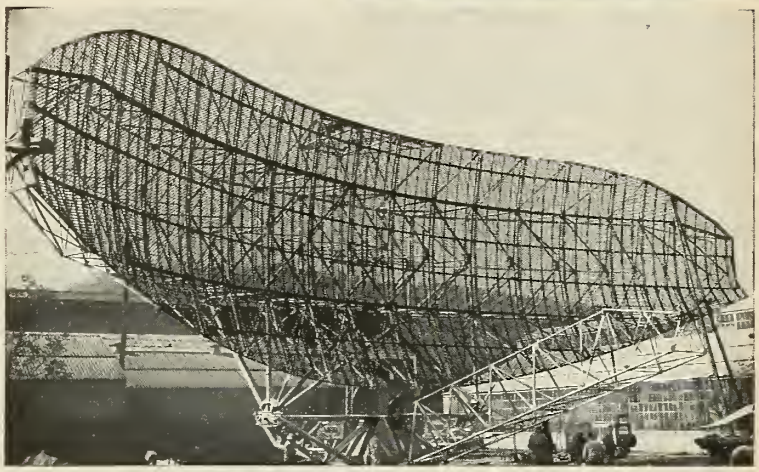
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Circle No. 19 on Subscriber Service Card

Apollo Beset by Avarice

THE NASCENT *Apollo* program appears headed for real trouble unless some firm measures are taken.

"The way things are going, I will guarantee that we will be second on the moon," comments one of the missile/space industry's top executives.

It is easy to blame the National Aeronautics and Space Administration for the situation. More than three months have passed since President Kennedy outlined the ambitious project to put a man on the moon ahead of the Soviet Union.

Confusion would be a mild word to describe what has been going on at NASA since then. The agency was not geared for a space race as such. Not only was a review and overhaul of *Apollo* objectives necessary, but a new look at the unmanned lunar program was needed.

Industry members have been quick to point the finger at the space agency for the difficulties which are bogging down the program. Certainly, NASA is responsible for much of the indecision afflicting the project. Naming of a chief for the project, due shortly, may put an end to the wheel-spinning period if he takes firm control. The appointment is overdue.

But the industry itself must take much of the blame for the situation which has developed. And if the attitude of many major members of the industry doesn't change, the *Apollo* program may wind up as a second-rate effort when the national interest calls for the best we can put forth.

There is an unseemly scramble among companies seeking a piece of the lucrative project. Teams are being formed only to dissolve as one or another member deserts to a more promising camp. The almighty *Apollo* dollar is being pegged at a higher value than company integrity.

The temptation is strong to throw both integrity and judgment out the window in view of the rewards in sight. This is perhaps concomitant with a program of *Apollo's* potential. Company survival may in some cases be at stake. The firm which fails to get a piece of the *Apollo* program may face a bleak future, particularly as the missile programs begin to run down.

But this is a situation the industry must learn to live with. While a considerable number of dollars are to be spent in the U.S. space effort, they will be spent on fewer programs. The time gap between programs will become longer and the unsuccessful bidder will not find, as he has found in the past, another program coming close behind to keep workers and machines busy.

The dangers arising from NASA's indecisiveness and industry's shyster business tactics are secondary, however, to a greater hazard which is almost inherent in a program of *Apollo's* size.

IT IS QUITE APPARENT that rather than risk losing a piece of the program, some major companies are prepared to tell NASA what they think NASA wants to hear, regardless of their own views.

Unless top NASA officials and responsible industry executives move right now to head off this trend, it can do incalculable damage to the lunar effort. Traditionally, our national strength has been based on the flow of ideas from industry to government. To cut off that flow at this critical time in our existence, to cut it off for reasons of greed, will assuredly place us behind the Soviet Union. If it happens, we will deserve it.

Yet we know of one major firm whose representatives admit privately that their *Apollo* proposal was not in their view the best approach. It was tailored to conform to NASA desires.

Integrity perhaps demanded less of a sacrifice in the days when a great variety of military aircraft were being procured. If you missed out on one contract, there was another competition coming up shortly. Yet we can remember when Ed Heinemann, then of Douglas-El Segundo, was willing to do battle with Navy brass concerning his ideas on lightweight aircraft. Some fine airplanes resulted.

More than ever, we need that kind of guts. The corporate risk admittedly is greater. But individual companies in the industry must put forward no less than what they believe is their best—and NASA must demonstrate its willingness to consider these ideas without prejudice.

If we then finish second, we will at least have run our best race. To do less, to let avarice overcome integrity, is, to put it in its bluntest terms, a betrayal of the nation.

William J. Coughlin



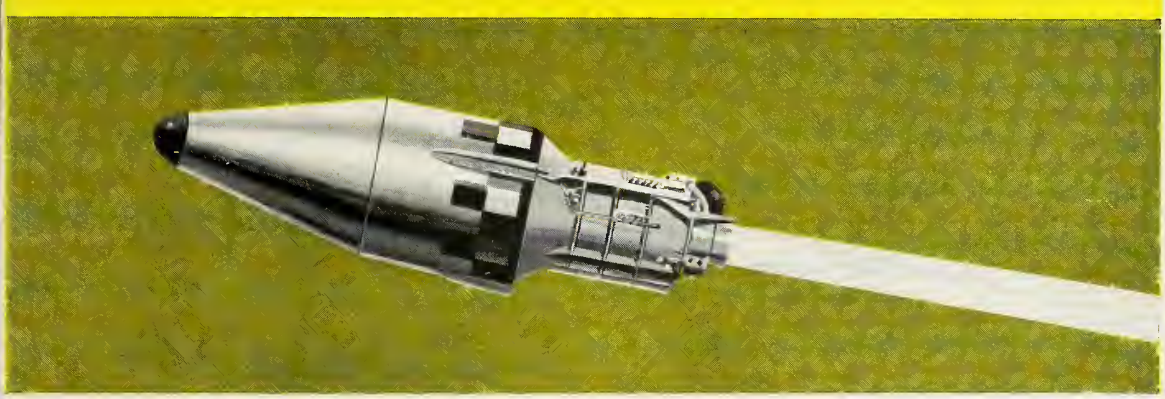
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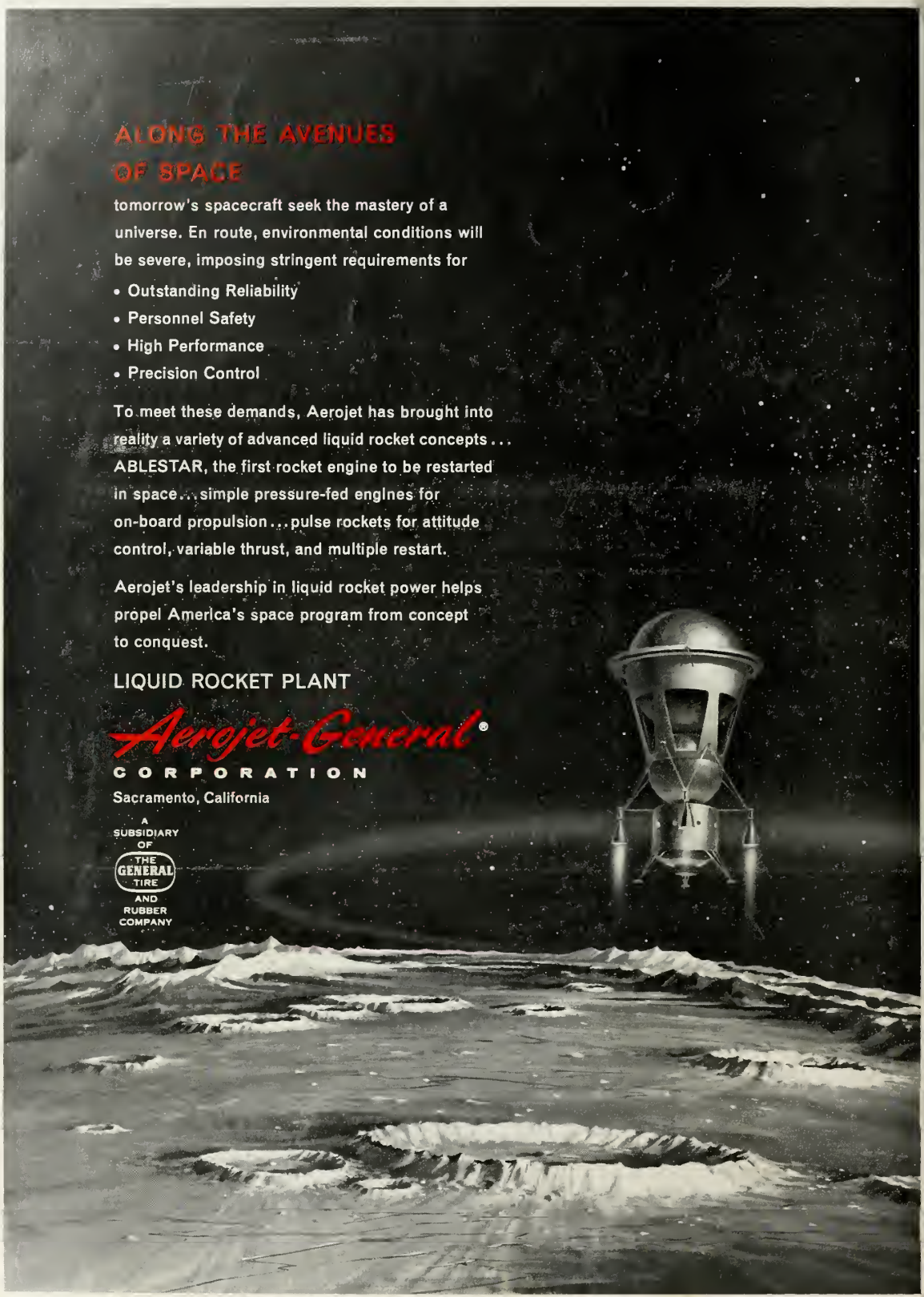
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